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Editor: L. Russell Muirhead, M.A.

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## Notes of the Month.

Science, indeed, knows no frontiers. On the same evening that General Smuts, at the Royal Institute of International Affairs, delivered his well-timed anathema against war-talk—"a vicious and dangerous mistake," as he justly described it—the Duke of Kent, at the annual dinner of the Institute of Fuel, awarded the Melchett Medal to Dr. Friedrich Bergius, the German chemist. Dr. Bergius's work has laid the foundations of a new fuel industry, the hydrogenation of coal, and he is now experimenting in the production of sugar from wood. The Duke of Kent stressed the international affiliations of the Institute, pointing out that the four previous medallists had been a German, a Swede, an American, and an Englishman.

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Hydrogenation in the sense of the addition of hydrogen to oils by the aid of nickel and other catalysts, has long been a commonplace operation in organic chemical laboratories. The more specialised meaning of the term, the addition of hydrogen to coal and its distillation products whereby it is converted into oil, started with the pioneering work of Bergius and has been continued in this country by the Fuel Research Board. The hydrogenation processes operated in connection with coal and its derivatives fall naturally into two classes: those working upon coal, and those treating oils derived from coal. Hydrogenation of the oils is a more simple process, not requiring the high heats and pressures demanded by coal. A semi-independent research by Imperial Chemical Industries has resulted in the process being put on a commercial footing in this country. Imperial Chemical Industries are now engaged in building a plant at Billingham which they hope will produce 150,000 tons a year of petrol from coal and creosote, beginning in the New Year.

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In his article in this month's *Discovery*, on p. 337, Dr. Alfred Noyes replies to Professor Julian Huxley's questionnaire on Science and Religion (*Discovery*, September, 1934, p. 268). Dr. Noyes has already written, in Chapter VII of his latest book, *The Unknown God* (Sheed & Ward. 7*s.* 6*d.*), his observations on the fact that the great "materialist" scientists found no great difficulty in recognising the existence of a "Supreme Architect" (Voltaire's words). Darwin refused to accept the "grand sequence of events" as the result of blind chance; T. H. Huxley admitted the "wider teleology," though he rightly attacks certain theologians *who were not his intellectual equals*. Our italics underline the root of the trouble; the cause of the angels has too often been left in the hands of unworthy advocates.

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The surprising speeds attained by streamlined railcars, recorded by Major Sinkinson in *Discovery* last month, have since then been exceeded. The comparatively long Diesel train of the Union Pacific R.R., which our article described, has succeeded in accomplishing the journey from Los Angeles to New York at an average speed of over 60 miles an hour, reaching a maximum speed of 120 miles an hour. As this was a train of several coaches, the Englishman may still look forward to securing his customary empty carriage in the expresses of the future!

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The *Statist* reports that it is probable that the Colombian Government will shortly attempt to reach an agreement with the Republic's foreign creditors. Some idea of the physical difficulties that Colombia has to contend with may be gained from Mr. Hornell's article in this issue of *Discovery*, while the recent travels of

Mr. Weston in the Goajira Peninsula throw light on the state of almost complete savagery in which some natives of Colombia still live. Our illustration shows that the Goajira women are still regarded simply as menials ; a man's life, as illustrated on p. 356, does not go beyond hunting and fighting.

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On the other hand, the *Statist* remarks, Colombia is the largest exporter of a particular kind of coffee which finds a ready market in Europe and a still greater market in the United States. And she is capable of growing nearly every form of agricultural produce which we associate with the tropics as well as wheat, maize, and the leguminous plants to which we are accustomed in these latitudes. In addition, Colombia possesses some of the richest mineral deposits in the world, including oil (meaning petroleum), gold, silver, copper, emeralds, platinum, coal, salt, sulphur, mica, manganese and opals, as well as a pearl fishery and certain kinds of natural phosphates. At the same time, natural difficulties, including three mountain ranges rising above 15,000 feet, make efficient transport a problem ; and with a population so small (less than that of Greater London) and an area so extensive (roughly a quarter of the size of Europe), obstructed by formidable difficulties, nothing but products which can bear an extravagant cost of transport can be moved any distance from the interior to the coastal ports.

*A Goajira water-carrier ; the Indian girls carry the* 100*lb. jars for many miles without complaint.*

* * * *

Long distance transmission of photographs by wired or wireless picture telegraphy has had spectacular publicity in the past months. Excellent examples of news pictures sent by the picture telegraph services which have been in operation for some years between London and various Continental centres were those of the assassination of King Alexander and M. Barthou at Marseilles and the funeral of the murdered king at Belgrade. Still more remarkable as a technical achievement was the photograph of the Duke of Gloucester sent from Australia by the Marconi facsimile system of radio picture telegraphy. But the crowning achievement was the transmission of 10 ft. of cinematograph film recording the arrival of Scott and Campbell Black at Melbourne, which was effected by the radio beam service, with sufficiently good images to permit projection in the public cinemas shortly after. Partly owing to insufficient advertisement, and the consequent lack of general realisation of the existence of picture telegraphy services, these have not yet been nearly as freely used as they might be both for Press and commercial purposes, but the prominence given by recent events to the possibilities which they afford should naturally help to expand the use of these facilities. Incidentally, we have noted one or two newspaper misdescriptions of picture telegraphy as " television " or " tele-photography."

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Each single " shot " of the film from Australia had to be transmitted separately. The enormous magnitude of the task may be gauged from the fact that for every second's showing on the screen no fewer than 20 pictures had to pass before the lens of the projector in the cinema. Each of these pictures took just over half an hour to transmit from Melbourne to Moorgate, and each picture when received measured 10 in. by 8 in. Each had then to be re-photographed by a cinema camera and reduced to the smaller size required by the standard cinema projector. A difficulty to be overcome in transmission was the fact that at certain hours of the day and night atmospheric conditions are unsuitable for the delicate task of reception of pictures by wireless. In spite of the handicap imposed by such natural interference, the transmission and reception of this remarkable film has shattered all records of photo-telegraphy in the world, opening up a new avenue in international communications.

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*East Africa*, the weekly journal devoted to East and Central Africa, has just published—to mark its tenth birthday—a valuable compilation, entitled *Eastern Africa To-Day and To-Morrow*. The editor, Mr. F. S. Joelson, has collected an impressive list of expert collaborators, and no part of Africa—or, indeed, of the Colonial Empire—has so far had the benefit of such comprehensive treatment in a single volume. Commercial production and industry have the lion's share of the book ; but sport is not forgotten ; and sociology and the native problem are adequately treated by Lord Lugard and others. The architectural photographs will surprise stay-at-home readers.

# Science and Religion

*(A reply to Professor Julian Huxley).*

**By Alfred Noyes.**

*Dr. Alfred Noyes, in this reply to Professor Julian Huxley's questionnaire on Science and Religion, uses not only his own authority, which has already been well demonstrated in his own writings. The words of other great thinkers of the past and present show that these questions have not escaped the notice that their vital importance merits.*

WORDS are dangerous weapons, and must be used with precision in a discussion of this kind. Professor Julian Huxley tells us, in the September *Discovery*, that the apparent dogmatism with which he dismissed the idea of God, in his two articles, was entirely due to the necessity of being brief. The remark, on so important a matter, is an odd one. However, he repudiates the statement attributed to him that "all religion which acknowledges a Higher Power than man" is a superstition, and that "belief in God is incompatible with a scientific approach."

He then asks a series of questions, in one of which a further admission is involved. "So far as we can see," he says, "the origin of the universe is beyond the range of scientific discourse."

At this stage, therefore, our discourse might very well end; for, if God be our name for the origin of the universe, our agnosticism may very well have thoughts worthy of the deeper silence. (Professor Julian Huxley will observe, I hope, that I have altered the classic phrase, in deference to his earlier suggestion that for science nothing is sacred.) He would probably object, however, if he were described in a court of law as "a man to whom nothing is sacred"; and a less idealistic man of science than himself, the late W. K. Clifford, once wrote, with something like passion, of the "sacred cause of truth." To this cause I believe that Professor Julian Huxley also adheres; and his questions, therefore, ought to be met. They are very old questions. Most of them are concerned with the reign of law throughout the universe, and the possibility of God's "interference" with it. If they are answered as Professor Huxley thinks they must be answered, he contends that his case is proven; and that "God (in the accepted religious sense, and not in the guise of a mere philosophical principle, of no immediate practical or psychological service to the worshipper) is gradually fading away as the result of science."

I have already been quoted, in *Discovery*, to the effect that the questions do not envisage the height, depth or complexity of the problems involved. The majority of them are so far from being "modern" that they are almost as old as philosophy itself; and certainly far older than Christianity.

Professor Julian Huxley seems to take their modernity for granted. Yet the "reign of law" has been the very ground of Theism for centuries; indeed, the great saying of the Old Testament, "Thy law is a lantern unto my feet," might be taken as the watchword of all true science and philosophy throughout the ages. The modern scientific conception of the "reign of law" is immensely in the debt of the sublime religious intuition which saw the whole universe moving in accordance with the one supreme Will. Newton was the child of that conception; and though, for some reason, Professor Julian Huxley speaks as if Newton had destroyed it, there are no more emphatic words in the history of philosophy than those in which Newton acknowledged it. "*The whole diversity of natural things*," he wrote in those great clear sentences at the end of his *Principia*, "*can have arisen from nothing but the ideas and the will of one necessarily existing Being, who is always and everywhere God Supreme, infinite, omnipotent, omniscient, absolutely perfect.*"

The questions are perennial, like the questions that any child can ask of Science itself. "Do you believe there is an end to Space? If so, what is beyond it?" In one form or another, they perplex the minds of most thinkers on religion at a certain stage in their development; for most of the questions involve at least one of those antinomies which perennially perplex Science and Philosophy no less than Religion. The questions on prayer, for instance, and the reign of law, involve the whole subject of determinism, freedom and moral responsibility; and, though Professor Julian Huxley ignores these deeper implications and asks for a clear, crisp, brisk, "yes" or "no," it is only when these deeper implications are made clear that a full and satisfactory answer can be delivered. Answer he shall have, but the grounds must be given first.

A corollary of the fact that these questions are very old is the fact that, in their right philosophical form (which is perhaps a little more precise and scientific than that given to them by Professor Huxley), they have been considered long and deeply by some of the greatest thinkers in history; and some very profound things have been said in answer to them. Professor Julian Huxley writes as if he really thought that re-

ligious thinkers were unaware of the "modern" scientific idea of "law." I venture to say that it is the very light of all their thought. It is through just this universal reign of law that, as Plato said, "the care of all things is made easy for the Ruler of the World." The fate of the sparrow could only enter into the reckoning under an infinitely perfect organisation. In last month's *Discovery* I quoted a Catholic writer of an earlier date to show his familiarity with the deterministic aspect of "law," and that he actually expressed it more precisely and scientifically than Professor Huxley himself. To make this quite clear, I will give a further quotation from this same Catholic writer, showing that his grasp of the idea was not limited to its more obvious physical aspects. He is discussing, in a kind of Platonic dialogue, whether it is legitimate to pray for the recovery of a child dangerously ill, and he makes his interlocutor say :—

"Pray God all day long that an eclipse shall come a week earlier : do you suppose you will be heard ? Yet the precise date of an eclipse is not more peremptorily fixed than is the precise issue of your daughter's fever."

Does this Catholic take refuge in evasion, then. No. He carries the deterministic argument on to the end :—

"Like a true Englishman, you take refuge in an illogical compromise. You assume one doctrine when you study science, and another when your child falls ill. And yet I am paying you too high a compliment ; for you do not profess that this latter doctrine is *true*. Your only defence is that your reason is mastered and overborne by emotion."

Could Professor Huxley have put it better, nearly a century later ? But our Catholic does not stop there.

"You see your mistake," he continues. "You will henceforth pray for spiritual blessings alone. You are still as unreasonable as you were before. Mental phenomena proceed on fixed laws, no less inflexibly than physical."

Could Professor Julian Huxley have stated *this* more forcibly ?

What, then, is the answer ? If that be the range of ideas in the mind of the religious thinker, it would surely be interesting to know what that kind of man has to say about it. The question on those great broad lines has been before the world for a very long time. It did not escape the attention of Newton who, more than any other man of science, was responsible for the modern scientific conception of law. We have seen the expression of his *Theism*, quoted above. Was Newton born out of due time, then, in the evolution of religion ? Had Newton missed those obvious little objections, which a poor mediævally superstitious Catholic writer expressed so precisely ? The technical discoveries and applied science of a later day have added nothing to the difficulty as that writer stated it. Has there been no answer at all from all the great minds that have so clearly stated both the problem and their faith ?

Answers have been given again and again—answers that go deeper perhaps than human thought has ever gone, on any other subject, answers from some of the profoundest minds in the history of philosophy and religion, some of whom have expressed themselves in words that cannot die. Professor Julian Huxley, in the two long articles which preceded his questions, does not even touch upon them. So far from any attempt to confute their answers, there is not one sign that he has even heard of either the answers or their authors ; not a single reference to any exponent of the theory which he is attacking. Indeed, the only figure to whom he refers at all, in these articles, is Lenin.

What should we think of a young man who came before the Royal Society, in order to overthrow a theory of the universe, and gave not a single sign that he had ever heard of the former answers by outstanding thinkers, to his own questions, although those thinkers had stated even his own questions better than he had stated them himself ? What should we say of him if his questions, legitimate enough in themselves, were framed for elementary intelligences and couched in terms that lacked precision—questions about the rising of the sun, for instance ; to which, if you said "No," he would reply that you were obviously in Egyptian darkness, while if you said "Yes," he would say that you had not heard of the Copernican theory ; so that at every step you had to cover ground that had been covered again and again in a thousand textbooks.

Pascal, in a few paragraphs, answered all Professor Julian Huxley's questions, centuries ago. Lotze, nearer to our own time, in his really great masterpiece, gave a complete answer on all the questions relating to personality (whose perfection he found only in a free and self-existent Being) and the mechanical or deterministic aspects of the universe. His reasoning, scientific and realistic throughout, has never been shaken. Contemporary science is more and more confirming his statement that the true life of science is to be found in "showing how absolutely universal is the extent, and at the same time how completely *subordinate* is the significance of mechanism in the structure of the world."

Contemporary religious thought is moving more and more steadily towards his view. Scientific determinism has not, for instance, caused us to abandon the ideas of freedom and moral responsibility upon which the whole conduct of our lives depends. It would be easy to ask questions about the "reign of law" which should make justice, love, friendship, and everything of value in our

lives, a mockery, by showing that we are nothing more than automatic machines. Nevertheless, though Professor Huxley's theories lead directly to this view, he repudiates them in practice by the warmth with which he protests against misinterpretations of his meaning. It would be highly irrational to be angry with automatic machines, or, indeed, to show any emotion at all. Perhaps a day will come when, as he says, " Science will be called in to advise us as to what religious and other impulses are 'intellectually permissible.' "

*Dr. Alfred Noyes.*

At the same time, it must be said that Professor Huxley has given a true account of what he actually sees. He will forgive me if I am bound to meet his own offensive with a counter-attack. If he ever does me the honour to read the tributes I have tried to pay, in my last book, to Darwin and his own grandfather, he will hardly think me lacking in appreciation of the agnostic point of view. He is right in many of his facts, as far as they go ; but I wonder if he realises how far the selection and interpretation of those facts depend upon a mood, rather than upon the scientific necessities of the case ; and how personal and subjective his whole method of thought may seem to others. It is quite obvious, for instance, that God has really " faded away " from his own mind " as a result of science." But the conclusions he draws from this are neither logical nor true. Darwin left it on record that, as a result of the specialised nature of his work, he had ceased in later life to feel the beauty of the masterpieces of literature. It had gradually " faded away " ; and, with the simplicity of true greatness, he confessed his fear that he had lost something of real value.

Professor Julian Huxley's phrase " fading away," in fact, describes a process of which I wrote in my recent book *The Unknown God*. I tried to show, in one of its chapters, that the specialists, the men who know more and more about less and less, are almost forced, by the nature of their work, to adjust the focus of their mental vision to diminishing fields of view ; and that, in all such adjustments, other and far more important fields of view are entirely shut out. It is the price that must be paid, perhaps, for valuable achievements in their own line of work ; but nevertheless, if the focus becomes fixed, their loss is great. Analysis always follows the dwindling road, explaining the greater by the less. The faces of our children may be composed of little planetary systems of electrons and protons ; and, if we could see them in that way, I suppose that in one sense we should be nearer to one kind of truth. But we should have lost another, and perhaps a more important truth. What would have happened to the values in the human countenance that signified most to us—the expression of the eyes, and the affection that shone through them ? Where do they reside amidst the spectral ballet of those revolving electrons ? Is it somewhere in the interstellar spaces, as they may be called ? In any case, they will have vanished utterly. Is it not certain that, in many cases, scientific analysis does, in an exactly similar way, lose sight of the chief values in the universe and announce that they have " faded away " into a non-existence which is nevertheless by no means synonymous with " fading away "? It seems certain that one kind of " science " while conducting some particular investigation, does often lose the real significance of the whole ; and that the real significance may be more apparent to the child whose vision is normally focussed, not on electrons, but on the expression in the face it loves best. Carlyle once remarked that a book ought to be written on " Spiritual Optics," and he suggested that the result might be as revolutionary as the work of Copernicus. In any case, this question of the focus of our mental vision has been amazingly neglected ; and, as a result, our philosophers, instead of co-operating in the service of truth, spend all their time in destroying each other's books because their vision is focused on apparently conflicting fields of view.

There is a similar danger to truth in Professor Julian Huxley's method of reasoning—the danger of an over-simplification of exceedingly complex problems—and the search for explanations in one set of facts, to the exclusion of all others. It is the danger of all inductive reasoning. I have no space here to give examples. I will merely offer the one phrase " Natural Selection." Darwin's facts were true, and his evolutionary theory may be true as far as it went ; but do they give us any-

thing like the whole truth about the emergence of the human race from a fire-mist? The danger, at one time, came from a certain narrow type of ecclesiastic. To-day, as Professor Julian Huxley has shown, the whole ground has shifted; and the excessive simplifications, into which all the richness and complexity of life must be fitted, come from another quarter. Professor Huxley will admit that when Bishop Wilberforce asked his grandfather certain celebrated questions, the verdict of the world was that the questions, in that form, were far too simple; and that their simplicity, engaging as it might be to the popular mind, betrayed a lack of acquaintance with the range and complexity of the problem involved. Professor Julian Huxley will not think, therefore, that this broad preliminary survey of the ground is unnecessary.

We can now examine some of his own words a little more closely. I have said that his terms are lacking in scientific precision; and I feel sure that this is because he has underestimated the subject with which he is dealing. In the chaos of modern opinion, it might be tactless to enquire what he meant by "God, in the accepted religious sense," especially when he tells us that this God is no longer "accepted" by educated persons. I am not helped very much by the statement that the current notion was, once, of a personal ruler, capable of "interfering" with the natural course of events, and that the current notion is now of "a much more shadowy Being." What he asks us to discuss is God "in the *accepted* religious sense," and, apparently, there is no "accepted" sense, but merely a Heraclitean flow of illusion. If he means God as a person, I must still ask whether he means the God of *Green Pastures*, with the top hat and the cigar; or the God who, according to the Bishop of Birmingham, can only do what His mathematical universe allows Him to do (*e.g.*, bring life into existence on planets automatically, at certain temperatures). Or is it the God of St. Augustine, the eternal spiritual Being (for if "spiritual" is what he means by "shadowy," I fear that Plato and St. John and St. Augustine have anticipated the "current" notion)? It is to this latter conception that the deeper thinkers of our day, from Gore to Von Hügel, and from Maritain to Dean Inge, have borne witness. But these are men whose minds are entirely open to the results of modern science; and, as a direct consequence, have found their belief in God, as the one supreme and eternal Reality, deepening and developing in every direction.

The God who is "fading away," says Professor Julian Huxley, is "not a mere philosophical principle." *That*, he implies, may remain for the delectation of philosophers. Our future Lenins may call upon Science for advice as to whether it is permissible; and Science will advise toleration; for it is a mere abstraction and means nothing. The God that really concerns us; the God whose "fading" is the subject of our current discourse, because it is so really important that the "fading" should be hastened—what God is this? Why, it is the very God with whom (if what Professor Julian Huxley says be true) I should have thought real thinkers were the least concerned! It is the God of the simple and the uneducated; God in the "accepted," but no longer current, religious sense. This is the God that is fading; and must be dealt with, firmly.

If there be thinkers for whom God is no more than "a philosophic principle," I agree with Professor Julian Huxley that their meaningless abstraction has no importance (even to Lenin), and is certainly not God in the "accepted sense" of the religious councils of Christendom, as embodied in the historic creeds. I can attach no other meaning than this to "*accepted*" sense. God, if God there be, is no shadowy abstraction, but the one ultimate Reality, the only absolutely Real Being, wherein all else begins and ends. Some of the attributes of that Being are forced upon our reason by considerations which have been perfectly stated by Herbert Spencer, in the first section of his *First Principles*—on the Unknowable.

Uncaused, because it is the ground of all things; sufficient to itself; perfect; omnipresent; eternal; absolute; supra-rational; and, finally, *supernatural*. All these words and phrases were used of that one ultimate Reality by the arch-agnostic; and, in using them, he was developing an argument accepted by the greatest and most various as well as the simplest minds of preceding ages, an argument that had been accepted by Voltaire (enemy as he was of the ecclesiastics) as fully as it had been accepted by Locke or Plato.

Of this ultimate Reality Spencer said (exactly as Newman and Voltaire said) that we were more certain than of anything else in our experience. It was the primary *datum*. "The belief which this datum constitutes," he wrote, "has a higher warrant than any other whatever"; and he added, "*in this assertion of a Reality utterly inscrutable in its nature Religion finds an assertion essentially coinciding with her own.*"

This goes far deeper than Professor Julian Huxley's question—"Is it scientifically necessary, or desirable, to postulate God as Creator, when, so far as we can see, the origin of the universe is outside the range of scientific discourse?" The terms once more do not envisage the real nature of the problem. "Outside the range" suggests merely a kind of distance which may one day be traversed or conquered by the human mind. Spencer, on the other hand, clearly demonstrated what had

(*Continued on p.* 354).

# The Polygraphic Process.

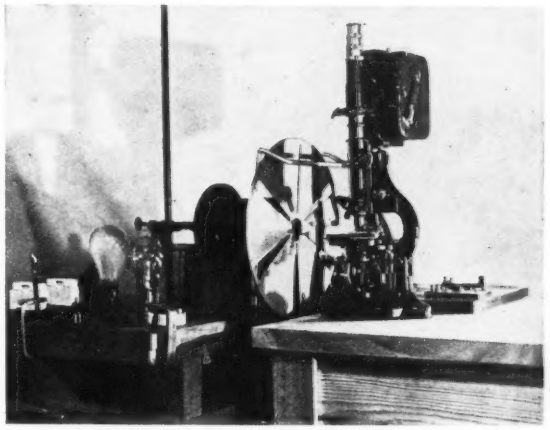
**By Ashley G. Lowndes, M.A., F.L.S.**

*Leverhulme Research Fellow, 1933 and 1934.*

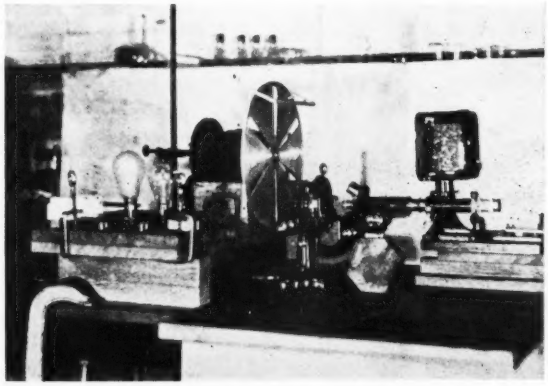
*A new process of ultra-rapid cinema photomicrography, which is both efficient and economical, is here described by its inventor. The main object of the process is the recording and measuring of rapid microscopic movement, but it has proved highly successful also when films were projected on the screen.*

ANYONE familiar with the observation of living objects under the microscope will readily appreciate the difficulty of either photomicrography or cinema-photomicrography of these objects, for in both cases it is essential that the motion should appear stopped. Reference to standard books on photography, such as that of Clerc,* will show that 1/250 in. (.1 mm.) is the greatest distance through which the final image may pass across the plate or film in order to give the impression of stopped motion. Obviously, if one is going to enlarge from such images, the distance given above must be reduced considerably.

Taking a microscopic animal such as Paramœcium, which moves with an absolute speed of 1.3 mm. per sec., and subjecting it to a magnification of 1,000 diameters, it will be obvious that it must pass across the photographic plate at a rate of 130 cm. per sec., and in order to stop the apparent motion, an exposure of 1/13,000 second is necessary. Exposures of this nature are hardly obtainable by ordinary photographic means, nor is the slow-motion cinema camera very much help. The best type of slow-motion camera with a single lens-combination is capable of working at the rate of approximately 240 exposures per second, each exposure being 1/3,000 second. Unfortunately, also, these high-speed slow-motion cameras, apart from their actual cost, which is something in the nature of £1,500, are very expensive to run. A slow-motion camera, running at the rate of 240 exposures per second, uses up negative film at the rate of 15 feet per sec., and thus, if the price of film is 3*d*. per foot, the film will be costing about 3*s*. 9*d*. per second. This may not sound excessive, but if one is dealing with spasmodic motion such as that of an insect jumping, or a minute crustacean, such as *Diaptomus gracilis*, leaping through the water, the difficulty becomes apparent at once. One may have to watch such an animal for some minutes before it will perform and, if film is being used up at the rate of 3*s*. 9*d*. per sec. while waiting, the problem becomes an impossible one. Other difficulties also arise. Cameras are not made to hold an excessive amount of film, nor are many slow-motion cameras at present adaptable to photomicrography.



*Here the microscope is set up vertically for high-power work.*



*The camera attached to the microscope in the horizontal position for low-power work, with the perforated disc ready to revolve as a high-speed shutter.*

In any type of photomicrography, vibration is always a difficulty, and vibration is always increased by a high-speed camera. Finally there is the question of measurement, for the primary object of the type of work under consideration is not so much the making of films for projecting purposes as the obtaining of accu-

**Photography: Theory and Practice*, by L. P. CLERC. (Pitman. 35*s*.).

rately-timed measurement of movement. These measurements can be obtained from the film provided that the rate at which it is running is known, but this assumes that the running rate of the film is constant, a matter presenting considerable difficulty. The film does not attain its maximum speed at once and, in a high-speed slow-motion camera, as much as 24 feet is frequently lost every time the camera is stopped and started. It is possible to get exact timing by marking the film every second or so by a special apparatus, and such an apparatus has been invented by Dr. Gray* and is in use at the Cambridge laboratories. I believe, however, that it is possible to get almost as accurate timing by a very much simpler method.

### The High-Speed Shutter.

In order to get over the difficulties mentioned, the polygraphic process was invented. This is really a very simple instrument and consists of a high-speed shutter acting in front of an ordinary cinema camera with the result that, instead of getting a single image on each little rectangle of film, several are obtained. The number of images obtained varies with the relative speeds of the two shutters, and in my first experiments about eight images were obtained on each little rectangle of film. If the object remained at rest, all eight images were superimposed, but if the object moved, the images were spread over the film. A certain amount of blurring of the images was inevitable but, for reasons to be explained later, this was far less than might be expected. Again, it must be remembered that the primary object of the process was to record and measure microscopic movement, and not to project films on the screen as moving pictures.

The apparatus used is so simple that very little explanation is required. The camera attached to the microscope in the illustration is that made by Messrs. Zeiss Ikon, under the trade name of the Zeiss Ikon Universal Kinamo. A Zeiss Ikon Microphot is also necessary in order to enable the object to be observed at the time of exposure, while a clockwork attachment is necessary, to act as a motor for the cinema. The total cost of the whole equipment, exclusive of the microscope, is approximately £50. The perforated disc, of aluminium or some such light metal, which acts as a high-speed shutter, is likewise shown in the photograph above. Each slot in the disc subtends an angle of 10°. The disc is attached by some suitable means to a small electric motor which rotates at the rate of 3,000—8,000 revolutions per minute. Suitable resistances are inserted, by which the number of revolutions per minute can be regulated. For a light source, a powerful open arc-lamp is essential. This is set behind the disc and a parallel beam of light obtained by some suitable optical arrangement. For low-power work, the microscope is set up horizontally as shown in the first photograph, while for high-power work, the microscope is set up vertically as shown in the second.

In order to make an exposure, animals such as *Diaptomus gracilis* are placed in a suitable glass-cell or narrow trough. The disc is set rotating at the requisite speed, and the light switched on. The operator then looks through the eyepiece of the microscope and, as an animal comes into the field, he presses the catch of the clockwork attachment, and a few feet of film are exposed.* Obviously a number of images are received on each little rectangle of film. If the animal is swimming very slowly, the images will coincide, giving a single clear-cut image, while if the animal makes a sudden leap forward or to one side, the images will be spread over the film.

The apparatus was first invented for the investigation of the swimming of entomostraca, but it was soon found that the applications were so numerous that it was decided to publish a description of the method and apparatus without confining its application to any single type of movement.

### Minute Movements perfectly Recorded.

Reference to a few prints taken directly by enlargement from the actual films will make this clear. The pair of photographs opposite show typical polygraphs of a single cilium taken from the edge of the gill of the ordinary edible mussel. The gills in question are covered with minute cilia or hairs which are constantly waving backwards and forwards. In one direction they move very slowly, while in the other, and particularly towards the end of the stroke, they move very rapidly. The final movement of this recovery stroke has never been satisfactorily filmed before, but it is claimed that it is shown almost perfectly by these two polygraphs. The film in question was made under 1/6 inch microscopic objective, representing quite high-power work. The method is applicable for any type of magnification. I have used it for filming a single limb of Chirocephalus or the antennules of Cyclops. It has been used also for filming the very rapid ripple-movements in ostracod sperms. This movement was filmed with a 1/12 inch oil-immersion objective, which implies of course that the highest powers of the microscope were used.

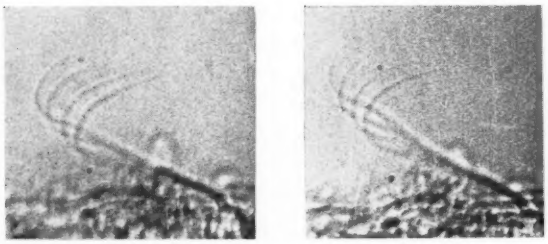
**The Mechanism of Ciliary Movement.* By JAMES GRAY, F.R.S. (Proceedings of the Royal Society of London, Series B: Vol. 107, No. B 751. 1930).

*The rotating disc functions as a very efficient cooling device. Chirocephalus appear to be quite unaffected by the intense but intermittent light.

The advantages of the method are at once apparent, but the two chief are speed and economy.

The speed, or rate of exposure, is almost unlimited, since it depends solely on the rate at which the disc can be rotated. At the present moment I have a disc with twelve slots which rotates at a speed of about 6,000 revolutions per minute, and with this I obtain over 1,000 exposures per second. It is obvious, however, that there is seldom any advantage in such a large number of exposures except in very special cases, and, unless the film itself is greatly speeded up, it means an excessive number of exposures on each little rectangle of film. This causes excessive blurring, and is undesirable. In actual practice, 300 exposures per second are usually ample and are easily obtained.

Since the film is travelling through the camera at a very ordinary speed, the economy is considerable, and since the actual speed of the film is irrelevant so far as timing is concerned, its movement can be stopped or started at any instant without any loss of film, which is a great advantage over the ordinary slow-motion camera. In the polygraphic process, the timing depends entirely on the h.gh-speed disc, and this can be kept

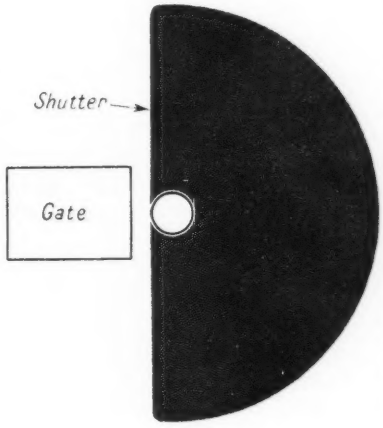


*Photomicrographs of a single cilium of a mussel in eight different positions, the series on the right representing a slightly later phase than those on the left.*

running all the time without the use of any film. Film is used only during actual exposure, and it can be stopped or started as the organism leaves or enters the field. In actual practice it is possible to film at the rate of 300 exposures per second, at a maximum cost of 3*d*. per second.

The chief disadvantages of the polygraphic method, beyond the ordinary disadvantage of any cinema process where the film is running intermittently, are *overlapping of the images*, and *blurring*.

In the ordinary cinema camera, the film is at rest during each exposure and in rapid movement during cut-off or non-exposure. In the majority of cinema cameras this is carried out by a rotating shutter which consists of a semi-circle of some opaque metal. Without going into details, it may be stated that the shutter rotates in front of the gate or a rectangular space, which carries the little rectangle of film. From this it is obvious that the time of actual exposure is approximately equal to the time of cut-off, and it is during the time of cut-off that the film is moving. Thus if the camera is making 20 exposures per sec., the time of such exposure will be approximately 1/40 second. In actual practice this shutter consists of rather more than a semicircle, and the times of exposure and cut-off are not quite equal. Working on this principle it is easily seen that if short exposures are aimed at by cutting out a smaller sector of the disc, the interval between the exposures will be lengthened, and this may have a serious effect. It is obviously impossible to rely on an organism starting one of its spasmodic leaps during exposure, for there is an even chance that the movement may start during cut-off.




*Cinema rotating shutter and gate through which the film is exposed.*

Now in the polygraphic process, assuming that the actual camera is making 20 exposures per second, while the high-speed shutter is making 300, each rectangle of film will receive 7½ exposures per second. Each exposure will be 1/1,800 second, followed by an interval of 1/360 second, but during cut-off there will be an interval of 1/40 second, and for the reason already explained this may have a most disastrous effect.

In order to get over this difficulty, a camera is under construction in which two films are working, and the arrangement is such that one film is exposing while the other is at cut-off. Details of this camera are hardly called for here, but its construction is well under way. Moreover, a certain amount of overlap is arranged for, so that the object will receive a continuous series of exposures at the minimum rate of 300 per second.

If the disc possesses 6 slots and each slot subtends an angle of 10°, while the disc is rotating at a speed of 3,000 revolutions per minute, the number of exposures per second will be:—

$$\frac{3{,}000 \times 6}{60} = 300$$

The number of exposures 1/40 second will be :—

$$\frac{300}{40} = 7.5$$

The mean time of each exposure will be :—

$$\frac{10}{60} \times \frac{1}{300} = 1/1,800 \text{ sec.}$$

While the interval between each exposure will be :—

$$\frac{5}{6} \times \frac{1}{300} = \frac{1}{360} \text{ secs.}$$

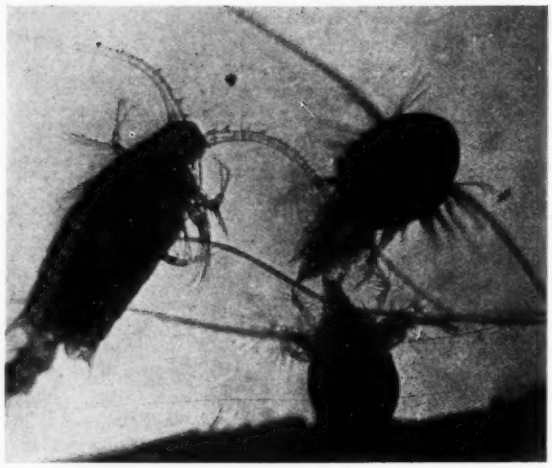
Overlapping of the images constitutes a considerable difficulty, and may make the interpretation highly difficult in extreme cases. So far, however, I have not encountered any case in which the superimposed images could not be separated, though it is doubtful whether they could be reproduced as photographic prints, or projected on a screen.

If several exposures are taken on a single plate, it is obvious that the first exposure will receive a number of further exposures which may cause a considerable amount of blurring or fogging. Actually this blurring is much less than might be expected, chiefly owing to two fairly well-known photographic phenomena. These are known as the Clayden Effect (CLERC, p. 137), and the Sabatier Effect (CLERC, p. 138). The former has the effect of preventing fogging to a certain extent, while the latter increases the sensitivity of the film. Again, for the investigation of movement, contrast rather than detail is required and accordingly an alkaline hydroquinone developer is employed.

The polygraph process was invented for the investigation of spasmodic movement of microscopic animals, without any intention of projecting the films. It was suggested, however, that the experiment of projecting a film was well worth trying, and when a short length of positive film was made and projected, the experiment was, on the whole, highly successful. Several difficulties present themselves, and how far these can be overcome remains to be proved. The chief difficulty is caused by the various stroboscopic effects, but the fact remains that in certain cases the polygraphed film gives a very clear and true record of microscopic movement which can not be obtained by any other method.

Single exposures of 1/5,000 of a second are easily obtainable, simply requiring a suitable disc with one slot to be substituted for a disc with many slots ; just the opposite, in fact, to obtaining a polygraph. An exposure of this nature is shown above, which represents a small marine Copepod, *Centropages typicus*, in motion.

So far the method is only in its experimental stages, and it would be foolish to state what is hoped to do with it. Further progress must be limited by at least three mechanical difficulties : rotation of the disc ; illumination ; and speed of the actual camera. The rotation of discs with a really high velocity constitutes an involved mechanical problem. At a high speed,



*Copepods in motion, photographed with a single exposure of* 1/5,000 *of a second.*

wind resistance becomes an important factor, and the discs must be rotated in a vacuum. Illumination also becomes a difficulty, but at present there is ample reserve in this direction, for in these days of flood-lighting there is no real difficulty in obtaining powerful arc-lamps. So far an arc-lamp taking 7 amps. has proved sufficient. If anything in the nature of 30,000 exposures per second were aimed at, a slow-motion camera giving something in the nature of 250 exposures per second would be required. Such cameras would be costly, apart from the cost of films, but, up to the present, I have been unable to foresee any insurmountable difficulty.

## Exploration at Home.

THE Le Play Society (58, Gordon Square, London, W.C.1), who are pioneers in the study of Geography by the regional method, have just produced a "Guide Card" (7*d.*, post free) which should be of the highest value to teachers and others interested in cultivating a sense of locality. The scope of the study-subjects suggested in this plan for Regional Survey ranges from bird-tracks to the influence of village institutes. It is doubly important nowadays that some idea of the individuality of places should be instilled into the coming generation. Modern mass-production and (involuntarily) broadcasting tend to abolish individual traits ; and only local resistance on reasoned grounds can check the conspiracy to deface the British countryside. And the Le Play Society, unlike some more official bodies, does not lay down the law ; it is wisely content to point the way.

# Noise : A Perennial Problem.

**By L. E. C. Hughes, Ph.D.**

*Dr. Hughes is the University of London Lecturer in Technical Acoustics at the City and Guilds Engineering College, where future engineers are regularly instructed in the properties of noise and noise-control. Here he outlines the really serious efforts that are being made to provide standards of noise-measurement, and suggests steps that might be taken to further noise-abatement.*

It is evident that the public and their servants, the politicians, are becoming noise-conscious, and are appreciating the social and industrial value of controlling the sea of noise in which we live. There was always a noise problem, and no doubt the problem will tend to become more acute as more mechanical appliances are added to our schemes of living. We do not know whether the mediaeval carts and coaches made as much din in passing over their cobble stones as our modern lorries on wood or concrete roads or our trains on steel rails, but we do know that the multiplicity of modern transport makes life miserable to a fair proportion of the community.

Our doctors tell us that noise and vibration are major sources of nervous troubles ; unfortunately they do not, or cannot, tell us why some persons suffer from a given onslaught of noise, while others are comparatively immune. It may be that education plays a part here, for many can concentrate on intricate mental or manual processes amid chatter or music or less definite noise, while others demand substantial silence. There seems to be some psychological factor in the relation between distracting noise and work in hand. Super-sensitivity to sounds normally arises with frayed nerves due to worry or illness, when the ticking of a clock may become magnified to a hammer-blow.

The acceleration of a sound is of great importance. The rise and fall in the noise-level from a passing vehicle may not disturb a sleeper, but the sudden blast from a strident hooter can arouse a neighbourhood. The advent of nocturnal silence for motor horns has proved a boon and has not had any serious consequences to the traveller. On the other hand, many repose contentedly beside railway stations, and some cannot have a good night's rest without an occasional blast from a steam whistle.

Short of actual pain in the ear, most people can withstand considerable intensities of sound for medium periods, without distraction from their work. There is a period of adaptation, but although it is known that the onset of considerable noise means increased metabolism, this increase is generally well within the capacity of the worker and alteration in noise-level does not produce marked changes in output or overall fatigue. Thus, from trials in a weaving shed with ear-defenders, small plugs which limit the intensity applied to the ear drum, inconclusive results were obtained. Increased output has, however, been claimed as a result of reducing the noise-level by acoustically treating the walls and ceilings of a factory. Recent experiments with school children showed that their efficiency in doing simple tasks was not impaired to any great extent with the application of considerable noise ; music, however, lowered the efficiency. At the end of a fatigue test, noise has a greater effect than music.

Much information is thus available about noise and its effects, but not quite the right information ; curing the individual of noise-susceptibility might be a more practicable proposition, if we knew how, than the superhuman effort required to reduce noise in some instances, such as in tube railways.

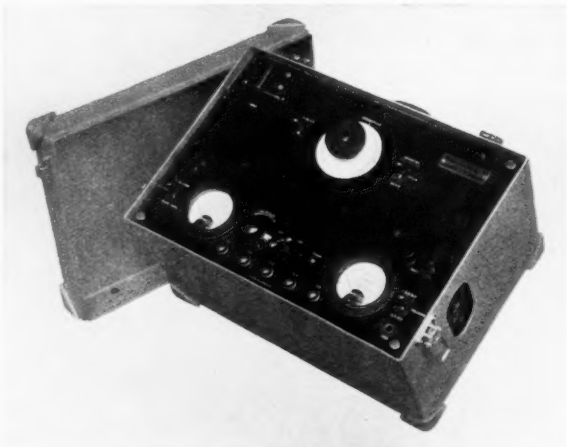
Within the last few years has arisen a movement for "no needless noise," culminating in the Anti-Noise League, which has already done excellent propaganda work and would do much more if further supported by the public. The combination of the increasing use of fast transport and a more deliberate use of the ears for listening, cultivated, no doubt, through broadcasting and sound films, has resulted in some public control of unnecessary noise. Previously something could be done only if the noise was proved a nuisance. Now we have nocturnal silence, control of the manufacture, maintenance, and loading of mechanical transport, and some attempt at mitigating the over-enthusiastic loud-speaker. This is a good beginning and the effect is being felt ; there is, however, much more to be done.

*The condenser transmitter, the internationally accepted device for measuring sound intensities.*

Broadly speaking, everyone knows what noise is ; a precise independent scientific definition is, however, elusive. The best that can be done in the way of words

is to declare that "noise is unwanted sound." We know a great deal about sounds and noises, their constitution of groups of musical frequencies, and the relative loudness of these components. As soon as noise control became desired, it was necessary to measure noise according to some scale. Fortunately, telephone engineers have been making precise measurements of sounds and noises for more than a decade; it therefore remained to produce apparatus for carrying to a place where a noise is, and measuring it in a generally agreed fashion.

Noise is a subjective phenomenon and therefore cannot be directly measured. The stimulus causing this impression of sound is a sound-intensity which can be defined and measured objectively, and is therefore the same for anyone who makes the measurement; the effect of a noise on a particular individual is thus eliminated. The precise way in which the measurement is to be conducted was under controversy for a time, but agreement among the leading countries, the United States, Germany, and Great Britain, along the following lines is in sight.



*A standard noise-measuring set made by the Western Electric Company. The noise levels are determined by the position of the dials and the indicating needle.*

Any sound, whether continuous, such as a siren or buzz, or transient, such as a click or bang, consists of a number of frequency components, the relative amplitudes of which determine the acoustic character of the sound. These components can be determined, if necessary, by frequency-analysing apparatus. The ear responds with remarkable variability to components of different frequency. Thus, for a frequency of 1,000 cycles per second, the median aural frequency, about two octaves above middle C on the musical scale, the ear is roughly one million times more sensitive than for frequencies of 50 or 15,000 cycles per second, which are towards the limits of frequency which can be detected at all. Likewise, the intensity tolerable before the ear experiences pain is roughly a million times more in the centre than at the ends of the scale. So that a medium-frequency component may be quite tolerable to the ear, while components of equal measured intensity but of considerably higher or lower frequency may be either inaudible or painful. A measuring machine which takes these complications into account over such a large range of magnitudes has no light task. Without the thermionic valve, with its capacity for immense controlled amplification, the measurement would be impossible.

Communication engineers find it inconvenient to use large scales of intensities, such as obtain in the ear, in sound measurements and communication circuits. A logarithmic unit, called the *decibel*, is universally employed. The length of the scale of tolerated loudness (as measured by the number of decibels by which any frequency component applied to the ear exceeds the intensity of the same frequency when it can be just detected) varies from zero decibels, for the extreme frequencies detectable by the ear, to a maximum of about 130 decibels, for frequencies in the neighbourhood of 1,000 cycles per second.

To simplify this complication, the unit of the loudness scale which applies to 1,000 cycles per second, although equal to the decibel at this frequency, has received the special name of the *phon*, so that the number of phons and decibels coincides for the loudness scale applying to the frequency 1,000 cycles per second, but for no other frequency. The procedure is to compare any unknown noise with the adjustable standard noise, 1,000 cycles per second, and then measure the loudness of the adjusted 1,000-cycles-per-second note on the phon scale. Normally the measuring instrument is previously calibrated in phons.

The adjustment can be made in one of three ways, one objective and two subjective. In the former, the microphone picks up a sample of the sound to be measured and amplifies it a known amount until it gives a particular indication on a meter. Because the ear does not respond with uniform sensitivity to different frequencies, the apparatus contains frequency-weighting networks which make allowance for this effect. The calibration of the apparatus, as indicated by the dials, gives the loudness of the noise in 1,000-cycles-per-second decibels, now called phons. This is the principle incorporated in the noise-measuring apparatus shown in

the illustration. One of the subjective methods uses aural comparison, that is to say, the 1,000-cycles-per-second standard tone is applied to one ear and adjusted in intensity until it appears to be as noisy as the noise being measured, which is applied to the other ear. The telephone applying the standard tone is previously calibrated so that it applies known intensities (according to the phon scale) to the ear. The other subjective method uses the masking effect of one sound for another. The 1,000-cycles-per-second tone is varied until it just vanishes aurally into the unknown noise. By a previous calibration, the adjusted standard tone is related to the phon scale.

The question now arises: Do the three methods agree? By the nature of the principles on which they are based, it is unlikely that they will give the same figures in phons for noises of widely differing character, such as whines or hisses or bangs. No comparison trials seem to be recorded. For particular classes of sounds, the relative readings will be reliable, and the way is ready for the specification of allowable limits of noise, as measured under stated conditions, for certain objectionable noises. This has, in fact, been done in Germany for motor horns and exhausts, the test having to be performed in a stated manner with a standard noise-measuring set.

This the reader, may object, is all very well for the expert with his noise-measuring gear, but how can anybody say how loud a noise is? The answer is that the best that can be done is to learn the noise scale in phons, much as we learn the physical meaning of the degrees on the Fahrenheit thermometer scale. There is no way of transferring an impression of noise from one person to another; a point on the noise thermometer must be given.

In the adjoining table are given a few representative noise levels; they are to be taken as typical only and subject to wide variations. More difficult to deal with is the transient noise, that which arises irregularly, such as motor horns or hammer blows. It is also known that high-frequency sounds are liable to be more irritating than lower-frequency sounds of the same loudness level. There is a movement to get motorists to use a more melodious tone for their audible warning of approach. One thing to combat is the prevalent commercial value of a "healthy sports note" in certain ostentatious types of car.

*Noise Levels out of doors due to various noise sources.*

*Survey by Noise Abatement Committee (New York) and others.*

| Distance from Source (Feet). | Noise. | Noise Level in Phons. | Noise. |
|---|---|---|---|
| | | 130 | Painful sound for medium frequencies. |
| 18 | Aeroplane (1,600 r.p.m.) | 115 | |
| 2 | Hammer blow on steel (indoor, very painful). | 114 | |
| 10 | Aero engine, unsilenced. | 110 | |
| 35 | Riveter. | 108 | |
| 10 | Pneumatic drill. | 90 | |
| 15-20 | Elevated electric train. | 89 | |
| | | 87 | Noisiest spot at Niagara. |
| | | 82 | Heavy traffic with elevated train, Chicago. |
| | | 75 | Noisy street, New York or Chicago. |
| 15-50 | Average motor truck. | 74 | |
| | | 70 | Very busy traffic, London. |
| 15-75 | Busy street traffic. | 68 | |
| 15-50 | Average motor. | 66 | |
| 3 | Ordinary conversation. | 65 | |
| | | 60 | Average shopping street, Chicago, and busy street, London. |
| 15-300 | Quiet residential street (afternoon). | 58 | |
| 15-50 | Quiet motor, minimum level in street. | 50 | Quiet motor, London; quiet street behind Regent St., London. |
| 50-500 | New York— minimum day | 42 | |
| | instantaneous night | 38 | |
| | | 30 | Quiet street, evening, no traffic, suburban, London. |
| | Quiet garden, London. | 20 | |
| 5 | Quiet whisper. | 10 | Rustle of leaves in gentle breeze. |
| | | 0 | Threshold of hearing. |

[*By courtesy of the Bell System Technical Journal.*]

Knowing how to measure noise, and therefore possessing the ability of demonstrating the effectiveness or otherwise of attempts at noise control, what can be done to mitigate this evil? Among major sources of noise, we know from last year's British Association that the noise in aeroplanes can be reduced to a comfortable level for passengers; little can be done for reducing the external radiation of noise. At this year's meeting, demonstrations of motor cycle silencing showed that marked reduction can be effected without appreciable loss in power. The Association has a committee to act on behalf of manufacturers of vehicles in combating the prevalence of noise in transport.

In the commercial sphere, noiseless design in such devices as typewriters has received attention, and much is to be gained in acoustically treating the walls of offices to reduce the noise level. The typists do not apparently increase their output, probably because they are generating the noise themselves.

Information concerning the reduction of noise arising from vibration transmitted from machinery is now abundant. First, the magnitude of the vibrational

force applied to any sound-radiating surface may be reduced by interposing resilient springs or pieces of cork or rubber (not felt), the dimensions being so proportioned that the natural period of the masses attached to, or in contact with, the resilient material is made very low in comparison with the frequency of the applied vibrational force. Secondly, the communicated sound energy may be reduced by interposing acoustic absorbing material in its path, such as baffles in ventilators. Thirdly, the resulting general noise-level may always be reduced by the acoustic treatment of the walls and ceiling of the enclosure where it is excessive. The most probable economic solution is to be found in giving attention to the actual cause of vibration in the machine.

Standard practice in noise-free construction is now available for architects, with ample selection of materials. Unfortunately, modern methods of steel-frame building and pipe-work provide excellent paths for the transmission of vibrational forces which ultimately give rise to noise. The transmission loss in steel framing is only one decibel per 1,000 feet, a loss which is acoustically negligible. Most modern housing is a disgrace from the point of view of sound transmission, considering the materials and technique available.

A world freer from noise can be attained in the future if the loss of amenity on account of noise is appreciated by everyone. It is a political cause which may be safely advocated by scientists to the less scientific powers that be. Quietude is a sentiment appreciated by most of us, but it is easily destroyed by the unthinking.

## Moving a Church.

*St. Andrew's Church, Kingsbury, Middlesex, has been removed stone by stone from Wells St., Oxford St., and set up in a new suburb. The photograph, specially taken for "Discovery," brings out the contrast between the Victorian Gothic of the church, and the modern suburban style of roads and houses.*

## Correspondence.

### OBJECTIVE AND SUBJECTIVE REALITY.

*To The Editor of* DISCOVERY.

Sir,

If a clear, glass sheet A has any word on its face at x, an observer originally at $O_1$ must move through 360° to $O_2$ to read the refracted image of the word. If, now, a mirror be placed at B normal to the glass sheet AA, the observer at $O_2$ will see a reflected image of the word in the plane AA identical with the word seen on AA from $O_1$.

That is, *from* $O_2$ the reflected and refracted images are identical in form (though not position), the reflected word-form being identical with the word on the *reverse* (remote from the observer) of AA as regards the relative position of the mirror and AA. That is, (*a*) the same form can be seen by the observer moving through 360°, or (*b*) *as reflection* without moving body or eye (as a whole) through any angular distance.

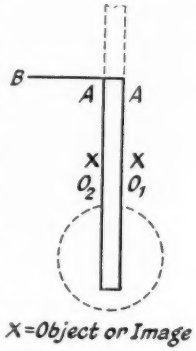



*Fig.* 1

Therefore (*a*) is essentially due to subjective effect; (*b*) to objective effect.

Can anyone trace the obscure, possibly important, relationship involved between Objective and Subjective Reality, here making itself observable as a subjective effect of 360° angular movement difference? Were the "word" perfectly symmetrical, form would be identical with or without subjective movement through angular distance. Can subjective evaluation of symmetry or form be fundamentally expressible (*i.e.*, not in the merely relative sense called perspective) in terms of objective angular measurement, remembering that angular measurement sweeps out all space? Whilst the end-point in both cases is identical in form and internal orientation, congruence is lacking by 180°.

A word on transparent paper easily substitutes the glass AA, such paper being then held normal to a mirror surface.

Another case, similar in content, though widely different in expression, occurs. A huge body—say the moon—may be imagined (ignoring obvious physical entanglements) close to an individual C. Its subjective angular effect on him may be regarded as 180°, thus:—Fig. 2. In size, M is subjectively continuous—*i.e.*, boundless. So that its complete form is totally obscured. Now, suppose it removed to its normal position—viz., 268,000 miles from C. Subjectively, its size is now discontinuous, its complete limits (in one plane) being simultaneously observable.

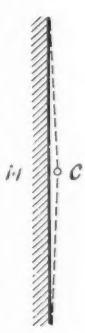



*Fig.* 2

Hence, subjectively, size continuity varies inversely with distance MC. On the other hand, subjectively, angular effect is unvaried with variation in distance MC. But this angular invariability insinuates itself differently in the two cases. In the first case it is expressed objectively—*i.e.*, by the proximity of the seemingly (subjectively) endless barrier. It is *visually* completely evidenced. In the second case it is expressed subjectively—*i.e.*, by mental reasoning based on the fact that whilst now completely delimited as to apparent size (just as a marble or stone

on the ground), no matter how far the observer walks in a plane parallel to its orbit, it continuously maintains substantially the same angular position with regard to himself. Its relative immensity is now only expressed by reasoning, not objective visibility. The existence of the angular effect is now only completely evidenced by *reasoning*. But its angular reality seems still almost as great as ever.

Here, again, what is the obscure relationship—possibly important—between Objective and Subjective Reality? Again, can subjective evaluation of symmetry or form be fundamentally expressible in terms of objective angular measurement, when angular measurement shouts aloud objectively at postulated close proximity, but hides behind the veil of subjective reasoning (being equally fully existent) under the influence of far removal?

The study of such natural distinctions may provoke ideas for psychologists, physicists, or organic chemists, which will lay a co-ordination basis between Objectivity and Subjectivity, thus leading to more exact evaluation of Subjectivity which is now, necessarily, ignored or taken for granted. Such basis is a crying need, if only to rescue Economics.

Yours faithfully,

S. C. BLACKTIN, M.Sc., PH.D.

Roundhay, Leeds.

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## ASTRONOMY AND MODERN THOUGHT.

*To the Editor of* DISCOVERY.

Sir,

The Rev. T. E. R. Phillips, in his contribution to the October issue of *Discovery*, makes the statement that:

> "In the last century the views taken may be summed up in Herbert Spencer's doctrine that the order of development is from the simple to the complex. . . . This does not, however, appear to represent accurately the facts as known to-day. The movement of cosmical evolution can hardly be compared to the movement of the traffic in a one-way street, for there are opposite processes in operation simultaneously. . . . Disintegration as well as synthesis has its place in cosmic physics."

Now, anyone who cares to turn to Spencer's "First Principles" will find that the chapters on evolution are followed by one on equilibration, and this is followed by one on dissolution—or "disintegration," to adopt Mr. Phillips's word. Moreover, if he turns to Section 182*a* of the sixth edition of that work (1900 or later) he will find Spencer saying that "in many thousands of places throughout our Sidereal System there are going on alternations of Evolution and Dissolution," and giving a wealth of evidence in support of this view. The very idea that Spencer dealt only with evolution, neglecting equilibrium and disintegration, is absurd to anyone who has attentively read even the one work above quoted from—much more so to anyone who has made a study of his many other works, including the "Principles of Sociology."

May I say that all writers who undertake to discuss cosmic theories in the present day would do well to make themselves thoroughly acquainted with all that the mighty mind of Spencer placed before the world during the latter half of last century. They will find him adopting the view that matter is simply energy—a view which scientists then would not accept, though twentieth-century science has proved it to be true. And so with other doctrines of his—they were highly heterodox when enunciated by him, but are now commonplaces of science.

By the way, why does Mr. Phillips use the word "annihilation" of matter, when he merely means the conversion of matter into energy? The word annihilation means the complete blotting out of a thing, leaving not a wrack behind—whereas the conversion or transformation of matter into energy leaves just as much energy after the process as existed in the matter before that process.

Perhaps I may be permitted to add that in the November issue of *Discovery* Mr. Phillips's quotation of Sir James Jeans's assertion that "the Universe begins to look more like a great thought than like a great machine" reads as if this view were a strikingly new one taken only by the enlightened scientists and philosophers of this present century. Yet the same thought was expressed by Spencer some three-quarters of a century ago. In the "Principles of Psychology" we find him saying in Section 63 that "it seems easier to translate so-called Matter into so-called Spirit than to translate so-called Spirit into so-called Matter (which latter is, indeed, wholly impossible)." I quote from the Third Edition of 1880, but the first edition of this work was issued as early as 1855. I have not access to this early edition at the moment, but I do not doubt that a similar thought is to be found in it.

Yours faithfully,

GEORGE EASTGATE.

Stanley Road, Woodford, E.18.

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## MODERN GREEK SPELLING.

*To the Editor of* DISCOVERY.

Sir,

At the end of a very generous and well-informed notice of our book *From Olympus to the Styx* your reviewer complains of our spelling of Greek names. We agree with him that complete consistency is impossible; but we have been less unprincipled than he suggests. Greek names may be (*a*) ancient, (*b*) mediæval or modern. Ancient names, to avoid horrors like "Thoukudides," seem best reproduced in the familiar Latinised forms; therefore "Lebadea," "Cephisia"—("Kephisia" conceals the connection with the River Cephisus familiar to English poetry). In a few cases Greek vowels have been kept, rather than the Latin form, as making the pronunciation clearer: "Peirene" is less misleading than "Pirene," which invites shortening of the first syllable. Mediæval and modern Greek names can be more closely transliterated without jarring old associations; therefore "Kalabaka," "Kalamata," "Monemeasia."

The map, alas! is guilty of more misprints than one; but of that the authors, who were not allowed a revised proof, are innocent.

Yours faithfully,

F. L. LUCAS.

King's College, Cambridge.

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## The Country-Side Diary.

The British Empire Naturalists' Association, jointly with Messrs. Charles Letts & Co., have published "The Country-Side Diary and B.E.N.A. Year Book for 1935" (leather, 4*s*., cloth, 2*s*. 6*d*.), under the able editorship of Mr. Richard Morse. The weekly and monthly notes and the photographs are as good as ever; the Hints for the Field Naturalist are a mine of information; and Sir E. John Russell, of Rothamsted, contributes a foreword which alone would be worth the price of the Diary. Certainly, a valuable pocketful for all nature-lovers.

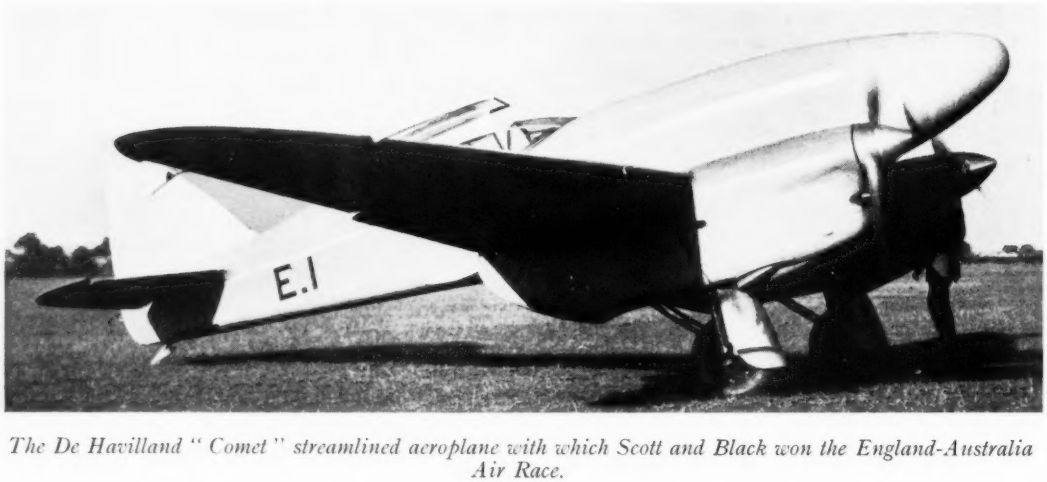
# Travelling Fast.

**By J. L. Nayler, M.A., F.R.Ae.S.**
*Secretary of the Aeronautical Research Committee.*

*The cardinal factor of speed in travel is the guiding principle of transport construction to-day. Mr. Nayler gives details of the latest developments in the "streamlining" of aircraft, which made possible the amazing speed of the winner in the England-Australia Air Race.*

MANKIND continues to take longer hours of leisure and is, therefore, anxious to complete his business at a greater rate. The consequence is a demand for higher speeds to transport either him or his goods and letters from one place to another on the surface of the earth. This insistent demand is bearing fruit in many directions at the present time and it is only necessary to remind the reader of the streamline railcar, of the streamline motor car, and of the streamline aeroplane to bring back to his mind the importance that is being attached to reducing the air resistance of all kinds of vehicles. The air resistance is the dominant factor at the highest speeds, and in aircraft its reduction is the sole consideration once the type, size and duties of the aircraft have been defined. Here we shall confine ourselves to the fastest type of aircraft, the aeroplane, although, for long distance transport, there are undoubtedly considerable future possibilities in the airship, for, as we have lately been reminded by the Press, the *Graf Zeppelin* has now flown more than half a million miles. On the other hand, the De Havilland "Comet" which won the air race from Mildenhall to Melbourne has a speed which no airship is ever likely to rival.

For a beginning it will be useful to see what has been accomplished already by aeroplanes on established transport routes, and after that we may discuss the main scientific principles behind the attainment of high speed. The air services of Europe are served largely by aeroplanes which, in the light of the results of the recent air race from England to Melbourne, must be considered as slow. The reasons are mainly that the distances between the capitals are relatively short measured in terms of hours in the air, so that the saving of time by faster aeroplanes has not the same relative significance as it has in the United States of America. Imperial Airways, for example, have developed aeroplanes like the Handley Page 42 which cruises at a speed of 110 m.p.h. This aeroplane carries 42 passengers, and has a total weight of 29,000 lb. and is fitted with four engines totalling 2,500 h.p. The designer of this aeroplane has concentrated mainly on increasing the comfort of the passengers. In the first place the volume of noise has been greatly reduced so that the conditions in the cabin are comparable with travel in an express train. In the second, the ventilation and heating are such as to promote comfort and a freedom from air sickness not previously attained in any aeroplane on similar duty. The load of paying passengers, etc., has also been increased to as high as possible a percentage of the total weight carried in the air in order to make the best of the



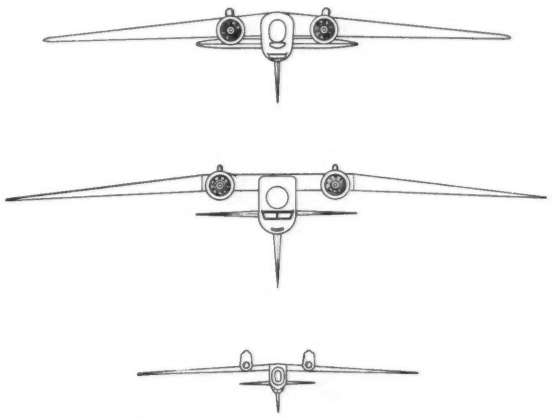

*The De Havilland "Comet" streamlined aeroplane with which Scott and Black won the England-Australia Air Race.*

aeroplane as a commercial proposition. From this point of view the slow aeroplane with a range of 300 to 400 miles can carry a paying load about 80 per cent. larger than another operating at a speed which is higher by 50 m.p.h. and flying 600 miles at a stretch. This advantage is counterbalanced to some extent by the fact that the faster aeroplane may be able to make two journeys instead of one in the same day.

When the distances are long, however, the paramount requirement is speed, and, where there has been this demand, faster aeroplanes have been designed and are operating. The United States provides an outstanding example of a very large country with the chief towns separated by long distances, and they have had an extensive air mail service, subsidised by the Government, for many years. The saving of time and the speeding-up of business between two places as far apart as Los Angeles and New York (3,300 miles) can be realised when it is remembered that the train service averages a speed of only 45 miles per hour and the air service about 160 miles per hour. The first fast aircraft used in quantity was the Boeing 247 with a cruising speed of 164 m.p.h. It is a monoplane weighing 13,650 lb., fitted with two Pratt and Whitney Wasp engines of a total horse power of 1,100. A machine of a modified type, 247-D, with a speed about 20 m.p.h. faster was the third to finish in the recent race to Australia. Its most recent competitor on the American Airways is the Douglas monoplane weighing 18,080 lb. and fitted with two engines (Wright Cyclone), of 700 h.p. each. This machine cruises at 180 m.p.h. and has a top speed of 200 m.p.h. One of the latest machines of the Douglas type was flown by pilots of the Royal Dutch Air Lines (K.L.M.), and finished second at Melbourne.

Both these aeroplane types are carrying passengers regularly over long distances in America. They have comfortable cabins and the Douglas machine flown in the recent race took 3 passengers the whole distance, arrangements being made to turn down the seats to make beds during flight either for passengers or crew. In the ordinary way, with normal arrangements for tanks to carry fuel, the Douglas D.C.2 carries 14 passengers a distance of 600 miles, but if only 8 passengers are on board the fuel is sufficient to carry them 1,200 miles at a cruising speed of 170 m.p.h. This last figure may be considered as the optimum so far attained by any air service in the world. In addition to finishing second in the England-Melbourne race, a new record has since been obtained with this type of aeroplane. Captain Rickenbacker flew on Nov. 8th in a Douglas air liner from Los Angeles to Newark (New Jersey), a distance of 2,609 miles from coast to coast in 12 hours 4 minutes. There were 6 persons on board and one stop only was made, at Kansas City. The average speed of the flight, made mainly at altitudes between 12,000 and 17,000 feet so that both crew and passengers needed and breathed oxygen, was at the very high average speed of 219 miles per hour.

Before passing to consider the possibilities of faster aircraft, it is of interest to note the weight of vehicle per passenger as compared with land transport. In the last number of *Discovery* Major A. P. Le M. Sinkinson gave a figure for first class express trains of two tons per passenger, if the locomotive be included. In the Flying Hamburger railcar the weight works out at three-quarters of a ton, and the passengers are transported at an average speed of 77 m.p.h. or some 7-10 miles an hour faster than the express train. We find that the Douglas aircraft can carry the same passengers at much more than double the speed over a distance in one hop of 1,200 miles for a weight per passenger of 2,200 lb. or a little more weight than in the railcar. For a shorter distance of 600 miles the weight per passenger is, however, less than 1,300 lb. This is not such an economical proposition as the much slower Handley Page aircraft, which is greatly faster than the train but weighs only about 700 lb. per passenger.

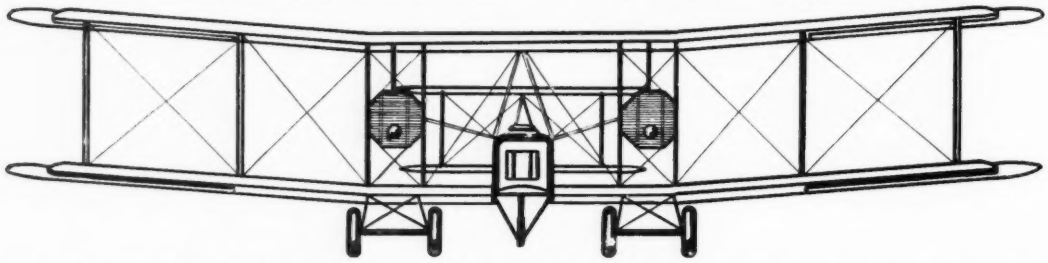


*Front elevations of the first three aeroplanes to finish in the race to Australia : (top) De Havilland " Comet " ; (centre) Douglas D.C.2 ; (bottom) Boeing 247-D.*

Now let us turn to the question of speed and how it is attained—and in so doing we must accustom ourselves to the certainty that within a year or two towns in England and Australia will only be three or four days distant from each other. This has been shown to be possible by the remarkable performance of C. W. A. Scott and T. Campbell Black in their De Havilland " Comet." They landed six times after leaving Mildenhall on their way to Melbourne: at Kirkuk, Baghdad, Allahabad, Singapore, Port Darwin and Charleville.

They flew the distance of 11,300 miles in 70 hours 59 minutes, of which 7 hours 4 minutes was spent on the ground. This represents a mean speed over the distance, including stops, of 160 m.p.h.

The "Comet" is a small low-wing cantilever monoplane of all-wood construction which has a top speed of 230 m.p.h., and can cruise at 210 m.p.h. for a distance of 2,900 miles. The two engines are Gipsy inverted six-cylinder air-cooled engines developing 224 h.p. at 2,400 r.p.m. with a compression ratio of 6.5 to 1. Both aeroplane and engine have been designed and built by the De Havilland Aircraft Company, Ltd., at Hatfield. It is essentially a racing craft, so that the weight per passenger cannot be compared with that of the other aeroplanes mentioned. It should also be noted that its range in miles is much more than double that of the Douglas when carrying the smaller number of passengers. There does not, however, seem to be any reason why a "Comet" should not operate at the same speed over shorter distances and carry mail.



*Front elevation of the Vickers-Vimy aeroplane that made the first direct flight from England to Australia (Ross Smith and K. M. Smith; 1919).*

We now ask how the great improvements in speed have been attained. This becomes a little clearer if we consult the diagrams herewith of the record holders of the fastest time between England and Australia of 15 years ago and to-day. The sketches show the head-on views and give some idea of the air resistances of each. The diagram above depicts the Vickers "Vimy" flown by Captain Ross Smith and Lieut. K. M. Smith in the first direct flight to Australia in 1919 when they took 27 days to reach Port Darwin from Hounslow, Middlesex. They used a machine of the same type as that which had already flown the North Atlantic and their total horse-power from the two Rolls-Royce Eagle VIII engines was 700, more than that used by Scott and Black and half that of the Douglas machine of to-day.

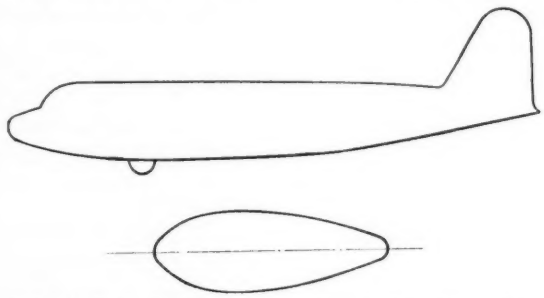
Their time included many stoppages for a variety of causes, but this only goes to emphasise how much more reliable, as well as faster, is the aeroplane and its engine of to-day.

All the first three to finish in the 1934 Australia race have a general similarity in frontal view and they are free from the large number of struts and wires that can be seen in the older plane. There are obstructions on the general elevation due to the body of the aeroplane and the two engines, and also to part of the wheels of the retracted undercarriage, but the result is the best that has yet been attained with present methods of construction and existing engines, apart from racing aircraft. In one respect, all three, and also all the other competitors in the race, differ from the Vickers "Vimy," and that is in using air-cooled instead of water-cooled engines. The reason for this is the smaller weight of the air-cooled engine for a given horse-power and to a less extent to the greater reliability of an air-cooled engine in such a race because it has neither radiators nor water jackets and so is not liable to the many troubles due to leaks which may occur when water-cooled engines are used under the great variety of temperature conditions met with when flying across the equator.

The marked difference in the frontal view of the "Comet" engines and those fitted to the American machines is seen in the next diagram. The former have only a small inlet for the air which is directed by baffles past each of the heads of the cylinders which are in line one behind the other. This type of construction permits a smaller frontal area for a given size of engine than the radial type, such as the Wright Cyclone and the Pratt and Whitney Wasp where the cylinders radiate from a centre. To reduce the head resistance of the latter a shaped hood or cowl is fitted which screens the tips of the cylinders and directs the air smoothly on to the engine nacelle behind. This cowl was developed as the result of a long research in the U.S.A. conducted on a full-size engine in a wind tunnel which directed over it a stream of air 20 feet in diameter. British radial engines use another cowl known as a Townend Ring. This ring, as fitted to the Atalanta type of monoplane and many other air liners, has been developed in Great Britain and produces also a reduction in head resistance. In addition, there is the resistance of the air through the passages past the cylinders and it is not known which type of engine, radial or in-line, is the less wasteful in

this respect. The tendency in Great Britain is to develop both types, the large in-line engine being composed of four banks of cylinders forming an H, and the corresponding radial engines with two circles of cylinders one immediately behind the other.

The last refinement in speed attainment after the frontal area has been reduced to a minimum is to make each of the fuselages and engine nacelles into a streamline shape. This last is still a loose term, but it is gradually being adopted in scientific aeronautics to imply that the resistance when head-on to the wind shall be only that of the friction of the air rubbing over the surface. For practical requirements it is necessary to have a given cross sectional area to contain at least a pilot. In the "Comet" the two pilots sit one behind the other, so that the front views of that and the Douglas show the difference between the accommodation considered necessary for just a pilot, and for a passenger cabin with two seats abreast and a gangway between. Having fixed on this dimension the best shape of body is then adopted and the next diagram shows a side elevation of the body of the "Comet" and the body of



*(Above) Side elevation of aeroplane body with undercarriage nearly retracted. (Below) Body-shape of same diameter offering the least possible air-resistance.*

smallest known resistance which has the same diameter. A shorter body than this has a higher resistance which increases up to that of a sphere. Whether it will prove possible or convenient to design shorter bodies for aeroplanes has yet to be determined, but a certain length is necessary so as to give a leverage for the tail organs that would otherwise assume much larger dimensions to provide enough stability and control. The engine nacelles approach this shorter body more nearly and can thus have a smaller resistance for a given frontal area.

There remains the undercarriage which is not completely withdrawn at present, since designers wish to arrange for a safe landing should the mechanism for protruding the undercarriage fully fail to work. There is little doubt that in the near future the half wheel, shown on the undersurface of the "Comet" body and which is actually under the engine nacelle, will be withdrawn and covered in completely to form a truly faired shape. This is far from being the case in the first three machines in the recent race, where the wheel fits loosely into a large hole under the body or nacelle.

The wings also present a resistance to motion through the air, most of which is due to the skin friction of the air flowing over the surface. Whether this is less for certain curvatures of surface or different wing sections or for different types of finish has not been definitely determined, but in a recent American machine an additional speed of three miles per hour on a speed of 170 m.p.h. was claimed when the whole of the surface of the aeroplane was thoroughly waxed. The remainder of the resistance is an inherent property of the wing and bears a definite relation to the lift exerted by the wings.

Before quoting the times that have now been accomplished on the route to Australia it is well to bear in mind that the air speed record for a short distance has recently been raised again by the Italian pilot, Sec. Lt. Francesco Agello, who flew a Macchi Castoldi 72 S (Fiat A.S.6) seaplane at an average speed over a three-kilometre course of 440.67 miles per hour. The question of keeping down frontal resistance was answered by placing two engines of 1,500 horse-power each in tandem driving on concentric shafts two airscrews both in front of the body. Moreover, the engines had the very low weight of only 0.7 lb. per h.p. This shows that the future possibilities of fast travel are not by any means exhausted, and it is even possible that the following records obtained by British "Comets" will not stand for long.

| | |
|---|---|
| England to Baghdad .. .. .. | 12 hrs. 40 mins. |
| England to India .. .. .. | 22 hrs. 13 mins. |
| England to Singapore .. .. | 39 hrs. 56 mins. |
| England to Port Darwin .. .. | 52 hrs. 30 mins. |
| England to Melbourne .. .. | 70 hrs. 54 mins. |
| England to Melbourne and back | 13 days 6 hrs. 43 mins. |

## Snake-Venom Cures.

The blood-clotting effects of certain snake-venoms have been known for years, but it is only recently that the discovery was made that, in the right conditions, the poison of some snakes can be used in alleviating, if not in curing, the disability of hæmophilia—hitherto regarded as incurable. The collection of the venom has been carried out by the London Zoological Society, the medical research by St. Bartholomew's Hospital. Mr. Donald Thomson, of Melbourne University, has promised an article to *Discovery* dealing with the snakes of North Australia, many of which possess poison glands with peculiar properties.

## Invention and the Kettle.

THE story is often told of how James Watt was inspired to invent the steam-engine by watching a spoon held at the spout of a kettle being forced backwards and forwards by the steam. If this was so, it seems strange that he should have invented the reciprocating engine and not the turbine. However, the kettle has now come into the limelight again as a mother of invention.

Several years ago Dr. Charles Russ, of George Street, Portman Square, noticed that when the kettle in his surgery was boiling the lid rattled violently and summoned attention. The idea of using this as the principle of a patent alarm gradually took shape, and at the beginning of this year he made his first experimental model. In the light of later developments it was crude, but it was the principle that mattered. The first model was an ordinary kettle, except that the spout joined the body at the bottom instead of at the top, while the lid was made of solid copper and had an adjustable resonator fitted on top. The lid was hinged at one side and clipped down at the other. The latest models have no hinge, no clip, and no resonator, but the principle is exactly the same.

As soon as steam begins to be generated the pressure in the kettle rises abruptly. There is no escape by the spout as it contains a column of water; the only thing

*Two of Dr. Russ's patent humming kettles; a copper kettle for the stove and an aluminium electric kettle. Note that in the former the spout joins the kettle at the bottom; in the latter the spout is continued inside. In the centre is the patent lid which provides the alarm.*

for the gas to do, then, is to lift the lid, and this it does as soon as there is sufficient pressure. Directly the lid lifts a fraction of a millimetre from its seating steam escapes, the pressure drops, and the lid falls back to its seating; and so it goes on. At first the lid gives a few desultory bumps, but soon settles down to a vibration of high frequency which causes it to emit audible waves, the pitch of the sound depending on the weight of the lid—that is, the strength of the force tending to keep the lid in its seating. It is probable that the surface-tension effect of the condensed steam round the lid-seating helps in this direction, also. When the water is nearly at boiling point the vibration of the lid is so rapid and constant that it is almost impossible to see it with the naked eye.

The sound emitted is not obtrusive, being only just within the audible band, but it carries remarkably well. When some kettles were being demonstrated at the Inventions Exhibition at the Central Hall, Westminster, in October, a small electric aluminium kettle fitted with the patent lid was audible at over fifty feet, in spite of the shuffling and the general conversation. This system is applicable not only to kettles; Dr. Russ has applied it successfully to saucepans, and is now working on casseroles and ovens. The invention is patented, and will soon be put into practice on a commercial scale.

## Science and Religion

(*Continued from p.* 340)

already been affirmed by all the greatest thinkers on religion for many centuries, that the one absolute and eternal Reality, the permanent ground which has existed from eternity (the supra-rational alternative to that nothingness which *might* have been, and, rationally speaking, *ought* to have been)—this one stupendous Fact is for ever incomprehensible to us. It confronts us—this sheer mystery—here and now, a Reality that, in its essence, is utterly inscrutable, though it may be "closer to us than breathing and nearer than hands or feet."

This assertion which, as Spencer says, Religion finds essentially coinciding with her own, coincides also with the separate findings of far too many and various minds throughout the ages to be set aside. It is the key to Plato as it is the key to Blake, enabling us

> To see a world in a grain of sand,
> A heaven in a wild flower,
> Hold infinity in the palm of the hand,
> And eternity in an hour.

The child who asks "Why should there have been anything at all?" is far nearer to an apprehension of the overwhelming Reality than are the elders who can accept the evolution of London, Paris and New York out of a cloud of gas as merely "natural" or, as Professor Julian Huxley says, "*explicable on ordinary scientific principles.*" Men can only talk like that when they shut the eyes of the mind, wrap up their true talent in a napkin, and refuse the treasure offered to them, not only by religion, but by all the forms and symbols of great art throughout the ages.

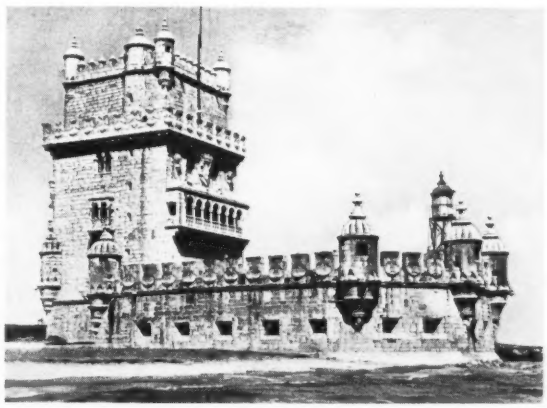
(*To be concluded*).

# The History of Science Congress.

**By H. T. Pledge, B.A.**
*of the Science Museum, London.*

*The Third International Congress of the History of Science, a subject which has suffered rather from neglect in British circles, was recently held in Portugal. Mr. Pledge indicates how appropriate the setting was, and points out the way to a better method of teaching Science as a whole.*

OF THE countries of Europe, few are more rarely heard of in science than Portugal; and yet there are few to which science owes a greater debt. Progress, in the modern sense of applied science and ruthless efficiency, has not yet reached the heart of Portugal. Yet it was from this westernmost country of Europe that an earlier sort of progress started. It was here that there began, about 1420, that daring process of maritime exploration, the last triumph of the chivalric spirit, which changed our view of the Universe; which made men see Europe as but one small continent on a vast globe; and which prepared their minds for the Copernican conception of that globe itself as no longer fixed and central, but as merely one moving item among others in a huge impartial emptiness. Indeed, it is hardly fanciful to say that exploring outwards must have led men to explore inwards, and so induced Vesalius (1543) to make his capital advance in our knowledge of human anatomy.



*The Tower of Belem, built by King Manuel I, marks the starting point of Vasco da Gama from the Tagus, and has become a national emblem of Portugal.*

There was thus nothing odd, but rather something very fitting, in the choice of Portugal for the third Congress of the History of Science; the second, reported in *Discovery*, August, 1931, having met at the Science Museum, London. Nor was there, perhaps, undue nationalism in the concentration of most of the papers on Portugal's contribution to science. A country whose mariners, first Dias, then Da Gama, then Magellan, rounded the Cape of Good Hope in 1488, ten years later reached India by sea, and finally in 1519 began the circumnavigation of the globe, may reasonably ask our attention for any other claims to originality.

The voyages of the great explorers were founded on prolonged study, by Prince Henry the Navigator and his school of experts, of the problems of navigation. On these we had papers by F. da Costa and by Q. da Fonseca. This study was essentially astronomical and mathematical, and was directly connected (looking forwards) with the northern school of astronomy beginning with such men as Regiomontanus and culminating in Copernicus, Brahe, and Kepler. Looking backwards it was connected, just as directly, with the main stream of mediaeval science. For when classical science at Alexandria broke down, its remnants found three principal refuges: Byzantium, Southern Italy, and the Mohammedan Empire which stretched at various times from beyond Baghdad across Northern Africa, through Spain and Portugal, and even into France. It so happened that while in Byzantium these remnants of early science merely hibernated until long afterwards in Renaissance times, and while in Southern Italy they only issued at first in the medical school of Salerno (11th and 12th centuries), the tiny élite of the Mohammedan courts was soon permeated by the spirit of science. Physicians, often Jewish, astronomers, mathematicians, brought light to the Mohammedan world, and especially to that brilliant Western Moorish Empire in Spain, while Christian Europe was still in darkness. On this subject perhaps the most valuable work of the Congress was done. The Commission of the "Corpus Medicorum Arabicorum" constituted some time ago to co-ordinate the efforts of individual Arabic scholars in the huge task of translating the works of these Mussulman physicians, now further defined its aims.

While the northward flow of this culture through Spain (12th and 13th centuries) resulted in strong theological schools among Mohammedans, Jews and Christians alike (up to about the 14th century), its more scientific aspects long languished wherever its original Jewish and Mohammedan impulse weakened. Then, as we have seen, these aspects found practical issue on the Atlantic seaboard; so that presently Iberian energies were absorbed in reaping the fruits of empire, while Italy, now strengthened by classical Greek elements from Byzantium, became for over a century the centre of science.

We select from the agenda of the Congress a few of the

papers of more recent and general interest. There were contributions on the 18th century, when European scientists were slowly digesting Newton and preparing for Priestley and Lavoisier; for instance, J. de Carvalho's paper on the introduction of Newtonian ideas into Portugal. One contribution was by the great historian, unfortunately not present in person, G. Loria of Genoa, on D'Alembert, one of the greatest of those who, in that century, used Newton's methods for further advances. Another was by Mme. Metzger of Paris on the bicentenary of Stahl. Stahl is a curious figure; one of the last to devote themselves in thorough-going fashion to making the old alchemical ideas account for the growing mass of chemical fact. It is hard to put oneself in the place of a generation to which the nature of a gas, or of the process of vaporisation, was an unending puzzle. That substances gave off vapours and thereby lost weight was well known; that these vapours ("spirits") could affect the mind ("Spirit"); that life departed with the breath (another vapour) was also realised. The bracketed words give some idea of the resulting confusion of thought. It was the work of the 18th century to clear this up; Stahl's theory of "phlogiston," with its negative weight, was at least a *scientific* theory, in that it was definite enough to be refuted by experiment if it proved wrong. That it did prove grotesquely wrong ought not to obscure this fundamental merit.

Interesting papers were those on the still-disputed question of priority in the invention of the dynamo (by M. Costanzo, Lisbon) and on the place of medicine in the history of science (by M. Abel Rey, Paris)—for medicine had its scholars, deeply versed in its history, when the history of other sciences had hardly begun. Finally, M. Reymond, Rector of the University of Lausanne, voiced the feelings of thousands of teachers in all the continents of the world when he pointed out that the only way to teach science as one single architectural unity is to teach it historically: a truth to which the Conference itself, drawn from universities in every country, may perhaps be regarded as a witness.

## The Goajira Indians.

TOWARDS the end of 1933 a small party of explorers, headed by Mr. J. A. Weston, penetrated the almost unknown Goajira Peninsula in N.E. Colombia, with the object of filming the savage Goajira Indians. These Indians, who number about 18,000, are completely independent. They devote themselves to stock-raising and possess enormous herds of fine cattle and horses, besides innumerable thousands of goats, sheep and donkeys. Owing to the difficulty of finding sufficient water and grass for their animals, the Goajiras have to be constantly on the move in their search for new grazing grounds and water holes, and they are consequently of a highly nomadic nature, rarely staying more than a few weeks in the same locality. There are no rivers in the Goajira and all water for domestic purposes and for watering the cattle and horses is obtained from deep wells. The Indian girls will walk many miles carrying the heavy water-jars on their shoulders, as illustrated on page 336.

There are about twelve main castes or clans of the Goajira Indians, subdivided into several hundred distinct tribes. Inter-tribal wars are fairly frequent, chiefly due to one tribe trespassing on the pastures of another. Besides their bows and arrows, many of the Indians possess ancient Winchester and Remington rifles, and their wars are of a very savage nature. Villages of the enemy are raided without warning and burned to the ground; the men are killed without mercy, and the women, children and cattle carried off by the raiders.

When sober the Goajiras are fairly tractable, but when drunk, which is nearly always, they will kill and rob without compunction. Owing to their nomadic nature they do not practise agriculture in any form and consequently they subsist almost entirely on meat and on milk products. The men devote themselves almost exclusively to hunting and fighting, and the boys, as soon as they can walk, follow in their fathers' footsteps. They soon learn to smoke, drink, ride and hunt with their bows and arrows and are proficient in all these things before they are eight years old.

*Young Goajira boys ready for the chase.*

# Progress in British Excavation.

**By E. N. Fallaize.**

*British archaeologists have not been idle during the Summer of* 1934. *Mr. Fallaize has summarised some of the most notable "digs" which have not been so far noticed in our columns. The results are important and interesting.*

ARCHAEOLOGISTS in Great Britain, in some cases taking advantage of schemes for the amelioration of conditions among the unemployed, have this year been more than usually active in excavation. Among the major operations the examination of Maiden Castle, the great prehistoric earthwork near Dorchester, takes first place, now that excavations at Verulamium have ceased. The excavation of Maiden Castle is being carried out by Dr. R. E. Mortimer Wheeler on behalf of the Society of Antiquaries, with the assistance of a number of students of various nationalities beside British. The great importance of this site for the prehistory of Southern Britain is already clearly marked and evidences have been brought to light of occupation from neolithic times to the Roman occupation, when the settlement was transferred to the neighbouring Roman city of Dorchester. The Roman building, thought to be a Roman villa when first discovered in 1882, has been shown to be a temple of the type familiar from the remains of Romano-Celtic areas on the Continent. Below the temple have been found the pit-dwellings of the stone-age peoples who occupied the site before it was fortified. The present plan of excavation will take three years to complete.

An interesting piece of work, and, as it has proved, not unimportant in its chronological results, has been undertaken by Mr. Alexander Keiller in the tracing and restoration of part of the line of West Kennet Avenue, which once led from the Great Circle at Avebury to the circles of Overton Hill. The Avenue had not previously been explored scientifically. A field, about five hundred yards long, at the middle of the course, is being excavated for post holes and hidden stones, and as the work proceeds the fallen and excavated stones are being re-erected. In reporting briefly on the results in the September issue of *Antiquity*, Mr. Keiller states that nineteen post holes have been discovered, as well as buried stones of which the existence was not suspected. A habitation site has also been found. The associated pottery is of the type known as Neolithic B or "Peterborough," and equates in date with the second occupation in the neolithic age of the important neighbouring settlement at Windmill Hill. Mr. Keiller proposes to devote three seasons' work to this restoration of the Avenue.

The prolonged and careful excavation of the Meare Lake Village in Somerset by Dr. Arthur Bulleid and Mr. St. George Gray, which has now been in progress for some years, though rarely sensational in its results, repays careful attention as it adds yearly to our knowledge of life in a settlement in the later prehistoric period in south-west England. Of the two halves of the settlement, the eastern alone occupied attention in this season's excavation. The excavators were engaged on a part of the site which offered somewhat puzzling above-ground conditions. In one of the mounds excavated a building, some thirty-eight feet in diameter, afforded an example of a twin series of superimposed hearths side by side. Of these one section was cut, showing no less than five superimposed clay layers in excellent condition.

Professor Gordon Childe's excavation of the now famous site of Skara Brae has taught us the great value and interest of these prehistoric settlements in the remoter islands of the north of Scotland, which, although known previously, have not received the careful attention they have now been shown to deserve. A site of a similar character to that of Skara Brae at Jarlshof, alongside Sumburgh Head, in the Shetlands, has been excavated by Mr. Alexander O. Curle on behalf of the

*Drawing of a Norse galley scratched on slate, from the Viking settlement of Jarlshof, Shetland.*

Office of Works. The settlement was first revealed in a storm some thirty years ago; but it is only the recent excavations that have made it possible to appreciate its importance. The site was occupied continuously from the stone age almost down to Christian times. Viking habitations abut right on to the prehistoric settlement. The remains which, like those of Skara Brae, had been covered with wind-driven sand, are in a sufficiently well-preserved condition to give a more than fair idea of the character of the dwellings which were used by the earlier and the later inhabitants. As might be expected in a remote settlement of this type the stone-

age culture must have lingered on to a comparatively late date, for the pottery which is found in association with stone implements is comparable with that of early iron-age type. The gradual transformation of the culture from stone to metal can be followed both in the objects of daily use, as well as in the succession of occupations of the dwellings. In the later prehistoric phases, when metal had come into use, bronze was worked on the spot, as can be seen by the number of bronze moulds found in the later habitations. A feature of the Viking culture is the large number of engraved slates which were found. Among the drawings is a very detailed sketch of a Viking galley.

Archaeologists have felt much gratification at the announcement of the generous gift to the nation of Stanton Brow Edge, by Mr. F. A. Holmes, as recorded in the November issue of *Discovery*. The numerous round barrows in the neighbourhood afford evidence that in the early bronze age this area must have been very thickly populated, while those who have visited the museums of Sheffield, Derby and Buxton will have appreciated in the wealth of relics of this period—funerary pottery, bronze implements and weapons and the like—the importance it holds in the records of the prehistorian. It is also rich in stone monuments, of which the best known are the neighbouring circle of Stanton Drew, and the still more famous Arbor Low.

## Unemployment and Research.

### By Guy Keeling.

THERE is now in progress an interesting experiment in the purposeful and constructive use of leisure. The movement, known as Grith Fyrd Camps,* was started 2½ years ago on a capital of £10. The object is to give young men, especially those who are unemployed, a chance of living a worth-while life in an environment that affords ample opportunity for developing initiative and resourcefulness. The scheme involves progressively: a period of training under *directive* leadership; widening of *experience*, with scope for adventure; and development of a *social* sense.

During these phases, and particularly the last-named, the members purely as volunteers devote a portion of their time to doing non-economic work—which does not compete with industry or in any degree take the place of paid labour, but is definitely of social utility.

*This title consists of two old English words: "Grith," meaning Peace, which appears to have had a positive meaning—not the mere absence of war, but the active adventure of the organisation of life under changed conditions; and "Fyrd," the name used by King Alfred for his citizen army.

Two camps are at present in being: at Godshill, near Fordingbridge on the edge of the New Forest, and at Alderwasley, on the southern end of the Pennines, 12 miles north of Derby. These Grith Fyrd Camps are permanent community centres, each of which accommodates, all the year round, young men up to fifty in number. Drawing on natural resources locally, the men meet, as far as possible, their basic needs for food, shelter, warmth and clothing. Their pooled unemployment pay is used for the purchase of requirements that cannot be met through the work of the camp. Nothing whatever is sold, either in the form of goods or services.

The scheme is simple in character and lends itself to rapid expansion and to wide variation according to local circumstances. Besides being taught handicrafts and economic camp management, the Campers are available for help in broad scientific research, though their help is not always taken advantage of.

### Useful Survey Work.

In the matter of the Land Utilisation Survey, for instance, a mobile group was wanted to help to clear up doubtful points and so expedite publication of the maps. The men are in no way restricted to camp, and this piece of public service has proved useful and successful from all points of view.

Attempts to carry through non-economic services, however, do not always meet with success. The field for archæological excavation, under skilled supervision, that would otherwise remain untouched, has been carefully investigated. The necessary expert supervision is admittedly not easy to secure. In two instances, however (in Hertfordshire and Somerset respectively), plans were drawn up to undertake archæological excavation which would otherwise not be done, only to be dropped as the result of opposition by the local authorities on the ground that if left sufficiently long (20, 50 or 100 years, say) the work *might* come into the local labour market.

There are undoubtedly many other latent opportunities for useful activities of a non-economic character. It is perhaps a matter which the Royal Society of Arts or some other such body might usefully investigate, especially in the scientific field, there is much work that it does not "pay" to undertake, but the doing of which adds to the total of human knowledge. If the universities could take actively in hand the provision of supervising scientists, there should, as the Unemployment Assistance Board gets into its swing next year, be many useful opportunities for developing this aspect of our national life. Those interested in the practical exploration of the matter are invited to communicate with the Secretary, Grith Fyrd Camps, Toynbee Hall, London, E.1.

# Through a Colombian Mangrove Swamp

**By James Hornell, F.L.S., F.R.A.I.**

*The Republic of Colombia, especially its Pacific Coast, is little visited. Mr. Hornell gives a graphic description of its attractions and disadvantages, fascinating to those whose interest leads them off the beaten track.*

THE little town of Charcas, the objective of the trip, is not to be found in any ordinary atlas or even on an Admiralty chart, although it is an inland port of quite considerable local importance in the Province of Nariño in the Republic of Colombia. It lies some ten miles up the Rio Iscuande which enters the Pacific Ocean through a wide channel, or *canal* as it is called locally, and is almost due south of the historic island of Gorgona where lay at anchor the research ship *St. George*, which had brought me to this unfrequented region. Few strangers visit the Pacific coastland of Colombia except those with business interests at Buenaventura or Tumaco, the only ports in direct communication with the outside world. For the trader and the globe-trotter there is no more inducement to penetrate inland at other points than there was for Pizarro to land when he and his little company of adventurers coasted painfully along this low-lying coast of dreary swamps in search of that El Dorado of which Balboa had heard such marvellous accounts.

*Prehistoric rock-sculpture of a monkey found between tide-marks on Gorgona Island, off the Colombian Coast.*

The chance that afforded opportunity of a glimpse of this seldom-visited land arose through the courteous invitation of the Port Captain of Charcas to the skipper of our ship to pay him an unofficial visit. He had learned of our arrival at Gorgona and, in discharge of his duty, felt bound to ascertain that our visit had no ulterior motive. So, the second day after we anchored at the island, a handsome dug-out canoe came alongside flying the tricolour of the Republic—yellow, blue and red—of dimensions preposterously large for the size of the little craft. Three Customs Officers came aboard; they arrived armed but with true Spanish politeness they left their rifles in the canoe. Besides a letter of enquiry and invitation to the mainland, they brought a welcome present of fruit from their superior officer. To dispel whatever doubts might be entertained as to the nature of our mission as well as to show our appreciation of the courtesy extended, our Captain decided to visit Charcas.

The ship's motor boat having one of its periodical fits of depression, we made the journey of thirty miles in the cutter, a smart little boat that sailed remarkably well. The senior Customs Officer was good enough to come with us as pilot, and fortunate this proved, for entrance to the river is difficult for strangers to locate. Two canoes, rigged with large spritsails, left at the same time with the kindly intention of accompanying us or, I fancy, of showing how easily their light craft could outpace our comparatively heavy boat. Before long, however, a smart breeze sprang up on the beam and we reached Punta Reyes, the nearest headland on the mainland, long in advance of the canoes. These craft sail well with the wind astern but make too much leeway to do well under other conditions, for they have neither keel nor lee-boards.

Punta Reyes is a low, sandy, treeless promontory about twenty miles from Gorgona. Here we met a fine old Spanish gentleman, Señor Fidel D'Cruz, descendant of a namesake whose services to the party of Colombian Independence in the early 19th century were rewarded with the concession of the island of Gorgona. We were particularly glad to meet him in order to obtain authority to remove from that island a number of sea-worn boulders on which some prehistoric race had graven the figures of a variety of animals including monkeys, a puma, and several kinds of birds. Permission was readily granted and these strange sculptures are now deposited in the British Museum.

Resuming our journey we were carried rapidly by the flood tide along the broad estuary of the Iscuande;

the glaring sandy coast, quivering with heat, soon gave place to the green and grateful shade of the swamp forest, seen at its best under the favourable conditions of weather and tide that then prevailed. On either hand tangled mangrove jungle rose, picturesque and majestic, the foliage and trunks of the trees raised high on flying buttresses of tall stilt-roots. These surely must have inspired the earliest builders of pile-dwellings in these swamps, who perhaps began by making flimsy leaf-shelters in the branches of the trees. Among them the tall *manglé*, noblest of the mangrove tribe, rears its grand crown of foliage high above its neighbours, with trunk so straight and durable that it is the favourite of the local boat-builders for making the masts of coasting schooners. It was high tide ; no land was to be seen, even the muddy swamps among the trees were temporarily obliterated, their place taken by glistening waterways, shady and inviting. Ever and anon a little canoe passed, manned by a couple of silent Indians, returning from some errand upstream. The stolidity of these rhythmically paddling Indians was in keeping with the setting ; solitude and quietude oppressed the beauty of the scene ; till the day began to close even bird life might have been non-existent for all evidence there was of its presence. But with the approach of night birds singly and in flights began to wing their way homeward. The channel was now gradually growing narrower. As the tide had turned and was again flowing seawards, flotsam from the forest occasionally streamed past ; once as a tangled mass of brushwood scraped along the side of the boat a coral snake ringed with scarlet, black and yellow raised a menacing head from among some leaves and at another time an alligator was seen, floating inert in midstream, showing just enough of his ugly snout to render him distinguishable from a piece of driftwood.

The lovely water hyacinth, the "beautiful purple devil" of tropical waterways, made little floating islets from which the tall and exquisite spikes of its pale purple flowers rose erect amid a platform of strong bulbous leaves.

*Typical growth of "manglé" mangroves, the tall straight trunks of which are invaluable as spars for coasting vessels.*

We had now sailed some six or seven miles from the sea, through a swamp without sign of human habitation. At intervals thereafter the banks showed a tendency to rise, the river proper, which we had at last last entered, narrowing to a few score yards in width. Solitary huts, melancholy and forlorn, began to appear, all built on piles raised well above the level of the stream. In front of most of them rose a simple cross made of two poles lashed at right angles and ornamented with festoons of palm-leaf strips. These are put up annually during the May *fiesta* to protect the house from misfortune during the year. The single room in most of these huts is surrounded on three sides by a closed-in verandah ; the fourth side connects with a platform laid with bamboos, sometimes open, sometimes lightly roofed in ; on this slight flooring the cooking preparations are carried on, the grinding of grain by means of a disc-shaped hand-mealer upon a flat slab of stone being the most important. A rough ladder gives access ; sometimes a tree trunk notched at convenient intervals does duty instead. Not a few of the huts, even the meanest, possess a little flower garden on the open platform ; in one instance the owner had raised alongside the house on forked sticks fourteen feet high a worn-out canoe filled with soil and this was ablaze with scarlet and yellow flowers. We were still a mile from Charcas when the weather changed to a tropical deluge, particularly dispiriting because, the wind having died away with the coming of the rain, we were now compelled to row laboriously against a strong current. As though by magic the scene was transformed. The picturesque sun-bathed banks became forlorn and dreary ; with the falling tide dismal morasses were taking the place of pretty waterways, and Charcas, when at last we arrived just after sunset, had the appearance of a town half drowned under a muddy flood. Our arrival was made in sorry plight, but the Port Captain and the Customs Officers gave us such a hearty welcome that we soon forgot our misery. A barrack-like guest-room was

placed at our disposal and the best refreshment that the place afforded—Colombian beer from Bogotà and some locally made and very fiery *aguardiente*—was brought in, together with a couple of musicians, to liven up our spirits. But after our musical friends had tried valiantly but with little success to accompany our singing of Auld Lang Syne—not altogether appropriate in the circumstances—we faced with what fortitude we could the hardships of a night which had to be spent either stretched out on the split-bamboo laths of beds without mattresses or in native-made hammocks of netting. The few mosquito nets we had were of little avail against the persistent swarms of hungry mosquitoes, attracted by brilliant lights kept burning long past the usual bedtime of the people here.

*Pile-dwelling on the River Iscuande. The old canoe raised on poles is planted with flowers—out of the way of the fowls and pigs.*

Charcas has a population of from 500 to 600. The "town" consists of an unpaved main street of about sixty houses disposed in a double row along the waterside. Each is of wood, built in two storeys, evidently a development of the pile-hut design, for the ground floor is utilised solely for storerooms or as a shop. This arrangement is possible, as the land is sufficiently high to raise the ground floors well above flood level. The houses are generally substantial and many of the inhabitants are well-to-do as values go in Colombia. The town is the local entrepôt, where produce collected from the forests around is sold or bartered for food and the little luxuries loved of the Indian and half-caste.

Morning, though welcome, showed the town in unlovely *déshabillé*. It was dead low water; the river ran, a dirty shrunken stream, between steep muddy banks. Slimy rubbish-strewn slopes led down to the water from the backs of the houses; mangrove-studded mud-banks showed up here and there. Landward, the dark, dank forest, choked with thick, tangled undergrowth, presses hard upon this one-street townlet; few footpaths lead into it; no roads exist beyond the two ends of the village—the river and the sea are the only highways in this region. Hence the little port is often crowded with small coasting craft that traffic between here and Buenaventura and Tumaco. Several schooners were loading at the time of our visit. A crowd of graceful dug-out canoes with broad scroll-shaped ends cumbered the bank, disappearing gradually on their daily duties as the morning advanced. Some had a *balsa* log, of a wood light as cork, lashed outboard along each gunwale to give greater flotation and stability and consequent power to carry large loads especially in troubled waters. In one, the logs were attached at the ends of cross-booms at a short distance outboard, making it for practical purposes into a double outrigger canoe—a working demonstration of how the characteristic craft of the Malay Archipelago were evolved from the primitive dug-out. Besides these, a curious vessel called an *imbabura* was anchored in the stream. This is a built-up dug-out from 32 to 40 ft. long, with sides raised by means of a deep washstrake flaring outward and bolted to wooden ribs on the inside, and with a stabilising *balsa* log tied to each side. Aft, the boat terminates in a square or transom stern, with a large hole in the centre; through this a long and very powerful steering paddle is passed.

Scarcely any cultivation is carried on around the town, which is purely a trading centre or emporium. The only workshop is a shipwright's yard where repairs are carried out and *imbaburas* built. A new mast was being prepared for a schooner; the invaluable straight-growing *manglé* was the timber selected.

At last the time to depart came round. A large part of the male population congregated on the bank above to speed us on our way, while upon the balconies of the larger houses a bevy of Spanish beauty suddenly appeared to gratify their curiosity. Several of these ladies were very pretty and might well have been born and brought up in Old Spain; the true Colombian prides himself of his Castilian ancestry, and on the purity of his speech.

The Port Captain gave us a farewell gift of fruit; a load of oranges was tumbled into the boat, and then, after the offer of a small porker at a price we thought outrageous, had been refused, we pushed off amid the loudly expressed good wishes of our Colombian friends.

## Christmas with the Cosmos.

*Books for Christmas, by all means! We make here a few suggestions for seasonable presents, some of which are, perhaps, a little out of the ordinary run of what are usually regarded as "Christmas books." A mention here does not necessarily imply that the book will not be reviewed in our columns later.*

In considering what books are suitable as Christmas presents for our friends, it is worth while remembering that many of the younger generation can do with something better than *Auntie Omega's Yuletide Annual* or the like and that their elders often welcome a little change of reading matter instead of the ordinary work of fiction, standard or otherwise. The volumes here suggested, therefore, are works of general interest which should appeal to anyone interested in what is going on in the world around him.

For sheer universality *Through Space and Time*, by Sir James Jeans (Cambridge University Press. 8*s*. 6*d*.) will take a lot of beating. In it the Cosmos is dealt with in the light of the most recent knowledge, from the interior of the Earth to the farthest nebular Universes—the whole illustrated by admirable photographs and told in straightforward language. The book embodies the lectures delivered by the author last winter at the Royal Institution, arranged as for a slightly more serious occasion. Though the Royal Institution audience is very largely juvenile, the effort of concentration needed to enjoy Sir James's magnificent work may perhaps be regarded as too much for some young readers. For these cases *Worlds in the Making*, by R. Barnard Way (Chatterbox Co. 3*s*. 6*d*.) may be commended. More briefly and in simpler language it conveys a very good idea of cosmic construction, and it is illustrated by clear diagrams and sketches. *Inside the Atom*, by John Langdon-Davies (Routledge. 3*s*. 6*d*.) approaches the Universe from the other end and endeavours, with some success, to deal simply with the physics of the infinitely small. This, too, is illustrated by sketches and photographs.

### The Eternal Quest.

More mundane matters, literally speaking, occupy the attention of another group of authors. *Nine Against the Unknown*, by J. Leslie Mitchell and Lewis Grassic Gibbon (Jarrolds. 18*s*.) is an "omnibus" of terrestrial exploration. The "nine" are Leif Ericsson, Marco Polo, Columbus, Cabeza de Vaca, Magellan, Vitus Bering, Mungo Park, Richard Burton, and Fridtjof Nansen, a splendidly international bevy of explorers. The uniting theme is "something lost behind the Ranges"—the search for the Fortunate Isles, the Fountain of Youth, El Dorado—an excellent corrective for the tame spirit and petty nationalism of the age. Necessarily narrower in scope, but equally thrilling in its way, is *Modern Buried Treasure Hunters*, by Harold T. Wilkins (Philip Allan. 10*s*. 6*d*.), with its tales of recent adventure in search of pirate hoards and Inca gold.

Photography for all purposes has made immense strides latterly, as any visitor to the exhibitions of the Royal Photographic Society can testify. Messrs. Chatto and Windus have taken advantage of this to introduce a series entitled *Life and Art in Photograph* (5*s*. each vol.), each volume with 100 photographs in illustration of a subject. The first three titles are *The Italian Renaissance*, *The Polar Regions*, and *Dogs*. The selection of photographs is admirable and these volumes may well serve as a pictorial index to written works on their respective themes. Some of the Italian subjects are pleasantly out-of-the-way; the Polar pictures offer a remarkable mixture of grim and friendly beauty and of human and animal interest; the dogs, as dogs, are perfectly displayed, and a critic, learned in show-ring lore, could take exception to the "points" of only one or two.

### Seasonable Thrills.

Spooks and the "supernatural" provide time-honoured Christmas fare. *Burn, Witch, Burn!* by A. Merritt (Methuen. 7*s*. 6*d*.) is a novel, it is true, but it conveys a grim impression of reality in its introduction of Sympathetic Magic into modern New York and, incidentally, gives a curious insight (like other novels we have read) into the running of American hospitals. It certainly provides the requisite creepy sensation. *The Mystic Mandrake*, by C. J. S. Thompson (Rider. 15*s*.) is an interesting account of one of the weirdest of superstitions, which actually prevails here and there even to-day. The illustrations are remarkable. In *The Peacemaker* (Heinemann. 7*s*. 6*d*.) C. S. Forrester succeeds in attaining his usual effect of actuality. This picture of a scientist who holds up the world's activities for its own good and is inevitably martyred is not to be missed.

Among animal stories the best that has reached us is *Widow Hedgehog*, by Phyllis Kelway (A. & C. Black. 5*s*.). The author's knowledge of the small events of the English countryside and her charming line drawings combine to make this animal biography into a real work of Natural History.

There are many other fascinating books waiting to be bought; and the faint-hearted who shirk the responsibility of choice may fall back on the Book Tokens of the National Book Council, which any good bookseller will supply, thus throwing the burden of selection on the happy recipient.

# Book Reviews.

*The Architecture of the Universe.* By W. F. G. Swann. (Macmillan. 16*s*.)

So many popular or semi-popular books have been published of late on the atom, the universe, the theory of relativity, and other outstanding subjects in physics and chemistry in which major advances have been made in our time, that a reader seeing another one of them reviewed might wonder if anybody existed to welcome it. Let him be told that if the book is good there is a welcome for it, or at least, there ought to be. It should not matter how often, or in how many ways, something worth discussing is discussed. Why should God's universe, as interpreted on the physical plane by living men and women, not have as many books on it as, say, the mystical poets of the 17th century, or the lesser novelists of Victoria's reign ?

Professor Swann, English by birth, American by residence, has in this book gone a long way towards doing for his audiences in the United States what Sir James Jeans has done in this country. Like Sir James he is felicitous of phrase and ingenious in analogy. He writes freshly, crisply and always very happily.

He begins with a chapter on the mediæval and modern dogmas in natural philosophy, in which some very wise words are said about the relation of mathematics to physics. He shows how mathematics cannot make discoveries for us ; it can point out, however, in an uncanny way the meaning of the discoveries we submit to it for examination. The next chapters are on the dawn of the modern era, the nature of matter and modern atomic theories. All this reading, relative to what succeeds, is easy. The plunge into the complex comes with the next chapters, which elaborate certain general principles of physics and discuss the fate of the universe. These precede the necessarily harder chapters on dimensions, on the restricted and the general theories of relativity, and on space and time. The concluding chapters are on subjects less usually dealt with in this kind of book : vital processes and the relation of science to theology. It was a happy thought not to leave these subjects out.

As regards the vexed question of difficulty, Dr. Swann has, we think, taken the proper line. Physics, philosophy, and mathematics, which are the staple of books of this sort, happen to be subjects not so easy as A B C. The important point is that they are matters in which the general reader should for his own good take an interest, even if, at times, they cost honest effort. Dr. Swann has not slurred over things by making difficult subjects look easy, but he has taken care not to overwork the difficulties. Thus, in mathematics, he has avoided almost entirely the use of mathematical symbolism, and he is politic and perhaps right in doing this, but he has quite correctly not attempted to avoid the discussion of mathematical ideas. Mathematical ideas are the things which count for a great deal in our understanding of the physical world. They are ideas, moreover, which any intelligent reader, not afraid of bogeys, is perfectly well able to understand.

The treatment while full, informed, easy, and up to date, is less amenable to philosophical " asides " than (say) the treatments of the same data by Sir Arthur Eddington or Sir James Jeans. Dr. Swann is content to regard the task of the physicist as the discovery of the relationships existing between the different phenomena which happen in our universe. Sir James Jeans would say—as he did at Aberdeen—that the task of physics is to reduce to law and order the impressions the universe makes on our senses. Dr. Swann does not take the line that the nature we study is our perceptions and not the things we perceive. He takes the simple view. He, like other writers, is interested in the question : Is an electron a particle or a wave ? But, unlike our philosophers, he does not seem to care whether electron waves are subjective or objective. Altogether he takes a more straightforward view of the data of physics than do other writers of semi-popular books on this interesting development. But he is at one with them in the clarity with which he shows how the newer work includes and comprehends all that was best in the old. This fresh, well-written book deserves an audience. We hope it will be widely read.

*Isaac Newton : a Biography.* By Louis Trenchard More. (Scribners. 18*s*.)

In undertaking a complete life of Newton, Professor More faced a formidable task, which, he says, has occupied him for seven years. It must be said at once that the book is by far the best biography of Newton that has ever been written. The author has been privileged to use the Newton Papers, long in the possession of the Earls of Portsmouth, and also the papers preserved at Cambridge and elsewhere. Furthermore, as a learned Professor of Physics at Cincinnati, he is qualified to explain exactly what discoveries Newton made and why they were of such transcendent importance in the history of Science. There seems to be no doubt that Newton's three fundamental achievements—the invention of the Calculus, the theory of Light, and the discovery of the force of Gravity—were all made by him in their elemental form when as a young man of 23 he had left Cambridge to avoid the plague and retired to his little estate at Woolsthorpe near Grantham in Lincolnshire. When Newton returned to Cambridge, he worked for twenty years in his rooms at Trinity elaborating these brilliant ideas. The *Principia* appeared between 1685 and 1687, and made him world-famous. " From its publication till to-day, the *Principia* has been the source of all theoretical physics, and so far as one can predict, it will continue indefinitely to be a model of scientific method." Newton did not publish his work on the Calculus till many years later.

A biographer must find Newton a difficult subject because he was very much of a recluse, extremely reserved about his work, and, we fear, desperately jealous of other workers in the field. Far too much of his life was taken up with violent controversies with Leibniz, Flamsteed and others, and, though Professor More describes these very clearly, it must be admitted that they are dull reading. What with these quarrels and with over-work, Newton, about the year 1693, was on the verge of a mental breakdown. He conceived that the Whigs, to whom he had rendered valuable service in 1688, were neglecting him, and he was positively rude to his best friends. However, when his young and brilliant friend Charles Montague, Chancellor of the Exchequer, made him Master of the Mint in 1696, Newton at last found life pleasant. He removed to London, set up a good establishment and lived very happily until his death in 1727, enjoying all the prestige that his great work and his position as President of the Royal Society had brought him.

Professor More has evidently tried to find some personal details which might relieve the extreme seriousness of his scientific chapters. But there is in truth very little of this nature to be gleaned. We learn from a former assistant of his how des-

perately he worked while at Trinity, neglecting food, taking no exercise at all, and scarcely ever mingling with the other Fellows of the college. It appears that the familiar story of his little dog Diamond upsetting a lighted candle on the manuscript of his lectures on Optics was the product of some university wag and is wholly untrue. We are told also that, although he died a wealthy man, he was no miser, but very generous in helping other men of science who were in need. It seems curious to a modern reader that Newton should have been interested in alchemy, and in abstruse Biblical studies such as now are unpopular outside Tennessee. But that is only to say that Newton, outside his scientific work, was a man of his age. As a scientist he was, of course, far in advance of his time. His fundamental work can never be superseded, though his conclusions may have been modified in part by the work of Professor Einstein and other physicists of our day. Professor More has written a valuable book which deserves every success.

*The Greatness and Decline of the Celts.* By HENRI HUBERT. (Kegan Paul. 16*s.*)

In a previous volume of the *History of Civilisation* series, the late M. Henri Hubert in a first instalment of his valuable and erudite study of the Celtic peoples has followed them from their earliest beginnings down to the Iron Age. In that age, or rather in its later phases, the La Tène culture, that culture of which the most characteristic and best-known manifestation is the elaboration of the curvilinear in all forms of decorative art, is identified as peculiarly the product of the Celt. Somewhere about the middle of the first millennium B.C. this culture, which appears first at the station of La Tène, near Neuchâtel in Switzerland, begins to expand over a great part of Europe in a succession of waves of migration and conquest. Archaeological and philological evidence alike point to a great eruption of peoples from central Europe, beginning at this time and continuing almost down to the Christian era. Of this movement, or series of movements, a partial and interrupted view is given in the records of the Celts preserved in classical historians and geographers.

The difficulties of the Celtic problem, which arise out of the variation of the Celts in physical type, and their lack of political cohesion, in the face of linguistic conformity and a certain cultural unity, were fully discussed by the author in the earlier volume. Here he examines the details of their expansion, in the course of which they invaded and subdued—or so the evidence is interpreted—a great part of Europe. Of this great empire Ireland alone survives in the modern political world, with a Celtic speaking fringe in the Highlands of Scotland, in Wales, and in Brittany. In a large measure, as M. Hubert shows, their decline was a result of the expansion of the Roman Empire and the rise of other peoples, such as the Franks and Saxons, on its disruption. Even at the time of their greatest expansion, however, the Celts never attained any form of political cohesion, to which the designation of an empire, strictly speaking, could be applied Such unity as can be predicated of the Celtic peoples M. Hubert is inclined to attribute to the institution of Druidism and its religious and philosophical concepts.

A great part of this volume is devoted to a reconstruction of Celtic civilisation, especially in its social, economic, and religious aspects. Here, the author had to rely on evidence drawn in the first place from classical authorities and secondly from the Irish and Welsh literary material, which is separated from his earlier authorities, as also from the day of Celtic dominance, by a very considerable period of time. The limitations of this evidence are obvious. Apart from its chronological discrepancy, outside Britain and Gaul specific customs and concepts are difficult to identify as peculiarly Celtic. Those which the author specifies, such as the priesthood, head-hunting, and the like, are Indo-European, or at least belonged to the Celts in common with the Italic and Indo-Iranian groups of the Aryan-speaking peoples.

Archaeological and historical studies are deeply indebted to MM. Marcel Mauss, Raymond Lantier, and Jean Marx for their pious work in editing and preparing for the press this valuable work of their late colleague.

*Secrets of Siberia.* By PIERRE DOMINIQUE, translated from the French by WARRE B. WELLS. (Hutchinson. 10*s.* 6*d.*)

M. Dominique, who knows his Russia, gives us here a vivid and obviously true picture of the progress of the Five-Year Plan in Central Asia. The depressing effect is relieved by bright patches. We may take off our hats, for instance, to the medical men and women of Russia, who have maintained their high tradition. It is characteristic that the masses think that crèches are not only the invention, but also the monopoly, of the Soviets. But, it must be remembered that in the same country the vast majority of the houses are bug-ridden, and most of the people lousy.

In this land, where window-dressing is carried out on a scale undreamt of even in America, where the factory areas are measured in miles, where 16,000 tons of machinery have been imported from Germany in a month, and been allowed to rot, the Soviets are exempt from that "damned economy," which has been said by a great authority to be inconsistent with efficiency. The Soviets have neither. Spendthrifts of both men and roubles, for there are no dividends to be considered, they are influenced not by economic considerations, but only by political, and that is what makes it so difficult for West Europeans to follow their workings.

Traktorstroi, where the factory area covers 36 square miles, was begun in 1929, designed to produce in 1933 no less than 20,000 tractors and 40,000 in the following year. At the time of the author's visit, there were 6,000 workmen employed on manufacture and 15,000 on assembly, yet he saw nothing but experimental, repair, and assembly work. A diminutive model factory, planned to produce only 250 tractors a year, after two years work with a staff of 1,200 workmen, had turned out only twenty-five.

Collectivisation has made some progress in Central Asia. Among the Sart, the sedentary population, about a quarter had been collectivised ; this suits their temperament as they are fed, but there is no stimulus to work. The more energetic and independent Kirghiz or Kazaks, the nomads, have scarcely been touched. These are hardly of the type that makes Communists, and they help to keep alive the torch of individualism, like the waifs and strays, the notorious *bezprizornie*, or free children, wild as hawks, who refuse to be tamed. Neither lend themselves to the conversion of humanity into ants or termites.

The greatest danger to Communism M. Dominique sees in the secular land-hunger of the peasants, on which Lenin played so skilfully, and which Stalin, the townsman, is now defying. The mujiks know that Lenin hath given, but Stalin hath taken away. Another danger he sees in the growing thoughtfulness of the masses. A Russian once said that the most important effect upon Russia of the Great War was that it taught their peasants

to think. Stalin is still teaching them. So perhaps one day we may yet see a true peasant state in Russia, though for the present the peasants are still almost as easily hoodwinked as ever, and their ignorance and indolence are powerful allies for the authorities.

The author makes no claim to have known the old Russia, which is the weakness of the vast majority of modern travellers to the country, for, having no basis of comparison, they are unable to distinguish between what is Soviet and what is Russian. There is no need, for instance, to waste sympathy on the peasants because their bread is black. Apart from the fact that they are to be congratulated on having to-day any bread at all, it is black and dark brown bread through generations that has bred that stalwart race of mujiks who made possible the miracles of Suvoroff, familiar to all who have watched Russian troops on the march. Nor is there need to criticise the failure or absence of baths in hotels, for this to them is a novel idea. The public Family Baths are an ancient institution, and every subject of the Tsars looked upon a Saturday visit to the baths as part of the normal routine of life. The author comments also on the difficulty in getting sheets in an hotel. At no time has it been the custom for innkeepers to provide bedding, except in the cosmopolitan hotels of the big cities, owing to the objection of the Russian to sleep between sheets used by other people, just as we do not like wearing other people's clothes. That explains why Russians always carry huge bundles on their travels; it is their bedding.

The author warns those who go on the trips of the Intourist that translations are expurgated, that statistics are falsified, that free conversation between Russian-speaking foreigners and workmen is all but impossible, and also very dangerous . . . for the workman.

The book is illustrated by standard photographs, and the translation from the French has been very well done. Unfortunately there is a serious blemish, in the retention of the author's spelling of Russian names and words, in French guise, as Gouguel for Gugel, Vorochilov, Kouznietsk, *kacha* for *kasha*, *kolkoz* for *kolhoz*; many of the renderings are inconsistent, apart from actual mistakes. This would have been avoided if the proofs had been read by someone who knows Russian. Allusions to sock-suspenders (p. 18), cork-tipped cigarettes (p. 64), and water-closets (p. 41) may be explained by mistranslation from Russian, or the influx of new habits. "Autarchy," self-government, is probably a slip for "autarky," self-sufficiency (p. 164).

*Weather*. By The Hon. RALPH ABERCROMBY; revised and largely rewritten by A. H. R. GOLDIE, M.A., F.R.S.E. (Kegan Paul. 10*s*. 6*d*.)

Abercromby's *Weather* was published in 1887, and the book was so soundly planned and so well written that it remained a standard work for over twenty years. In the last few years, however, meteorology has made rapid strides, and in preparing the new edition, Major Goldie has wisely allowed himself a very free hand. Even so, much of the original stands with little alteration, especially the chapters on "Synoptic Charts" and "Types and Spells of Weather," which include some of the most important of Abercromby's own contributions to meteorology.

After an introductory chapter, the book plunges at once into its main subject of synoptic charts, which show the distribution of pressure, wind and weather over a wide area at any given moment, and a large part of Chapter II is taken up with the well known classification of isobars into seven fundamental shapes, which is still one of the main bases of practical weather forecasting. Next comes a long chapter on "The Upper Air," which is entirely new, for in 1887 knowledge of upper air conditions was almost nil. The chapter on Clouds is enriched by a series of beautiful photographic reproductions. The next, on "Structure of Cyclones," is entirely rewritten, for the modern polar front theory is a product of the last twenty years. How the fine structure of cyclones, the alternation of day and night, heating and cooling, combine to give us local variations of weather is explained in a series of clearly written chapters, after which we turn to the broader aspects of the general circulation, types of weather and seasonal changes.

Major Goldie's (it would be fair to say "the author's") task must have been very difficult, but on the whole it is excellently done. Now and again, however, the mingling of old and new comes out rather strongly; for example the "structure of cyclones" is pure polar front theory, while "spells of weather" is all pre-war and the polar front is not mentioned. Abercromby's name is a great attraction, and it is good that his work should be kept alive, but we should, perhaps, have had an even better book if Goldie had started again from the beginning.

The book will repay readers who have some knowledge of physics, and the advanced meteorologist will appreciate the large amount of recent work which has been incorporated. Occasionally Goldie forgets that he is not writing entirely for experts, as for example on p. 158, where the curves of diurnal variation of warm front and cold front rain are quite inadequately explained, but such lapses are rare, and most of the illustrations are clear and helpful.

*The Cambridge Shorter History of India*. Edited by H. H. DODWELL. (Cambridge University Press. 12*s*. 6*d*.)

To write a history of a sub-continent in six volumes is possible when it is done by a team of authors, all specialists in their own department of historical research, but to condense these six volumes into one thousand pages is an almost superhuman task, in which failure would be no disgrace. But Mr. Dodwell did not fail. *The Cambridge Shorter History of India* is one of those rare successes that happen only once in a generation. It is a real history of the 5,000 years of struggle which have gone to the building up of our Indian Empire, not merely a rehash of the larger book.

The tasks which confront the historian of the early development of the sub-continent of India are almost insurmountable because of the lack of written material. In the valley of the Indus, for example, history has to be unearthed with the spade. All the knowledge we have of the civilisation of the Mohenjodaro region has been obtained through archaeology. That civilisation, in which there were bathrooms and houses with a really effective drainage system (which our American cousins would call culture), has left no written history, no lists of kings, nor of statesmen, nor of battles fought and won for the glory of a nation whose culture was superior to that of her contemporary, Ur of the Chaldees. It is not till we get to the almost modern times of 330 B.C. that we find written history as we know it to-day. It is due to the classical records of Alexander's Indian Campaign that we can piece together the first jigsaw puzzle of the comings and goings of India's potentates.

The history of India might be said to pass through the bottle neck of the North-West Frontier. It is through this narrow opening that all conquerors came until the Portuguese and Dutch sailed round the Cape of Good Hope, in search of trade and adventure. Down through the Khyber Pass has streamed the

fresh red blood, refreshing the inhabitants of the parched plains, who had lost their vitality and driving power in the heat and dust of the south. It was through this gate that the Aryan conquerors came and established the caste system. It was through this gate that Alexander came and established his short-lived Greek Empire. It was through this same gate that the Mohammedan conquerors came to establish the Mohammedan religion. Napoleon and Russia both tried to use this gate to India, but they found it locked and barred by England, because she had discovered that the country which holds India and the road into India is paramount in Europe.

England's entry into the field of Indian politics is so typically English that it is difficult to understand how it developed into the Indian Empire of yesterday. Charles II graciously consented to accept as part of his Portuguese bride's dowry the Island of Bombay, but, finding it too much trouble to govern this remote colony, he, with equal graciousness, turned it over to the East India Company to be held and administered for the Crown in perpetuity for a rent of £10 per year. Passing on through the years, we find Clive the ruling power in the Company, making enemies and building up an empire at the same time. If the advice given by Clive to the Government at home had been followed, we should have had the Indian Empire incorporated in the English domains a hundred years earlier.

*The Cambridge Shorter History of India* should prove invaluable to the student and teacher of Indian history: I might also add that it should be made compulsory for every Member of Parliament to pass an examination on this book; then, and not till then, would our legislators, in the mass, have a knowledge of that complex subject, our Indian Empire.

*Atomic Theory and the Description of Nature.* By N. Bohr. (Cambridge University Press. 6*s*.)

In this book are collected, together with an introductory survey, four essays by Niels Bohr which have appeared in various periodicals between 1925 and 1929. During these years the new quantum theory was discovered and its more important applications made. Like most physical theories, it began as an attempt to bring as many physical phenomena as possible within one mathematical scheme. In this it has been very successful, and has already been applied to atomic physics, chemistry, metallurgy, radio-activity and to many other subjects.

It is well known that the quantum theory has forced its exponents to take a more subjective view of physical phenomena than was usual before. They are unable to conceive of events within the atom as taking place independently of human observation, but hold that these events are only real when experiments to observe them have been carried out. Physicists were not driven into this idealistic position because it appealed to them for philosophical reasons; on the contrary, Schrödinger, who is responsible for one of the most important advances, hoped originally that his work would free the quantum theory of the "irrational" objective elements it contained. The idealistic position has been taken up because it has become gradually more apparent that the mathematical laws which physicists have been compelled to formulate to account for the experimental facts can only be understood and found to be free from contradiction when examined from an idealistic point of view.

Our understanding of this we owe to Niels Bohr more than to any other man. In his Institute for Theoretical Physics in Copenhagen, physicists from all over the world gather and discuss their theories under his guidance, and his genius has made a consistent whole out of wave mechanics, matrix mechanics and the other forms in which the theories were presented. This collection of essays, therefore, which explains his view of the nature of physical laws, has a unique importance as written by the man under whose leadership the whole fabric of modern theoretical physics has grown up.

It is impossible in a review to give any sketch of Bohr's views, since they are stated in these essays with such economy of words that further compression is impossible. But the reviewer cannot help mentioning the fascinating speculations about the nature of life and the possible limits to our knowledge of it. The Uncertainty Principle stands between us and a complete description of the inanimate world in terms of classical concepts, and in Bohr's view some similar principle may prevent the complete understanding of living processes in terms even of quantum physics and chemistry.

Owing to the concise nature of the writing, these essays must be read with considerable care; but the reader will be rewarded by an insight into some of the most profound thinking in modern science.

*A Wayfarer in Belgium.* By Fletcher Allen (Methuen. 7*s*. 6*d*.)

This is a worthy addition to the well known "Wayfarer" series. It is perhaps inevitable that so much of the volume—about one-fifth—should be devoted to Bruges, for Bruges is the quintessence of Belgium, and, however hackneyed it may seem to the *blasé* globe-trotter, it has always some fresh charm to reveal to really discerning travellers. Mr. Allen may fairly be numbered among these last, and there can be few corners in Bruges that he has not explored. He does justice, moreover, to Damme, that miniature and more moribund Bruges, which, like Sluis, was drained of its life-blood when the Zwyn river silted up. It is natural that a description of Sluis should be included in a Belgian wayfaring, as Sluis is more conveniently reached from the Belgian than the Dutch side, and is, in any case, more Flemish than Dutch. But Walcheren island and Middelburg have been rather unnecessarily dragged out of their place, which is in Holland; the space devoted to them might have been better given to some out-of-the-way parts of Belgium. The next edition (which this volume certainly deserves) should contain a description of the Waesland and the Campine, which may not be the most picturesque parts of Belgium, but are certainly characteristic; also some details concerning the wonderful church of Léau, which is as well worth seeing as any Belgian building. The Scheldt tunnel at Antwerp will no doubt also be included.

Particularly vivid are the descriptions of rebuilt Dixmude and the little story about the cycle accident in Ghent. The author has caught the grim practical character of the Flemings, likewise their deep-rooted love for their tortured motherland. He is perhaps a little, but only a little, less at home among the Walloons, and in any case they are among the least easily understood races in Europe. Incidentally there is room for a new study in English of their social culture and vernacular literature.

One awkward slip confuses the Treaty of Utrecht (1713) with the Union of Utrecht (1579), and the Turkijen Battery near Breedene would be better translated as "Turkey" rather than "Turkish," but the volume as a whole is refreshingly free from inaccuracies. Mr. Allen's work will certainly bear comparison with that of his colleagues in this admirable series.

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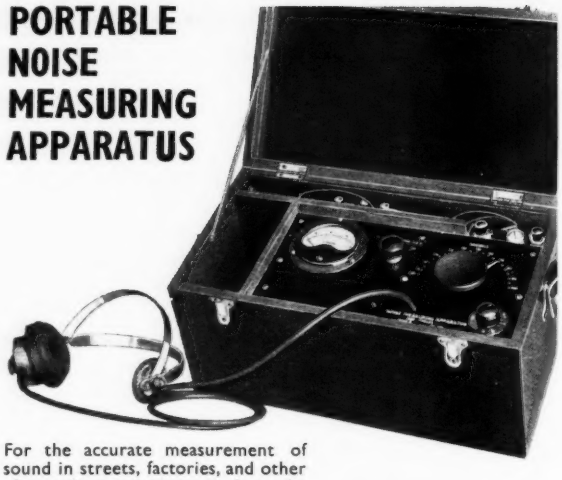

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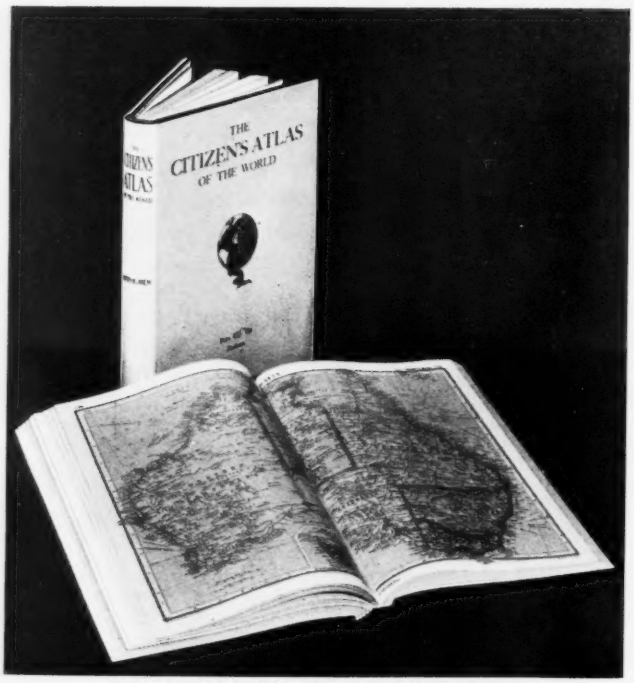


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